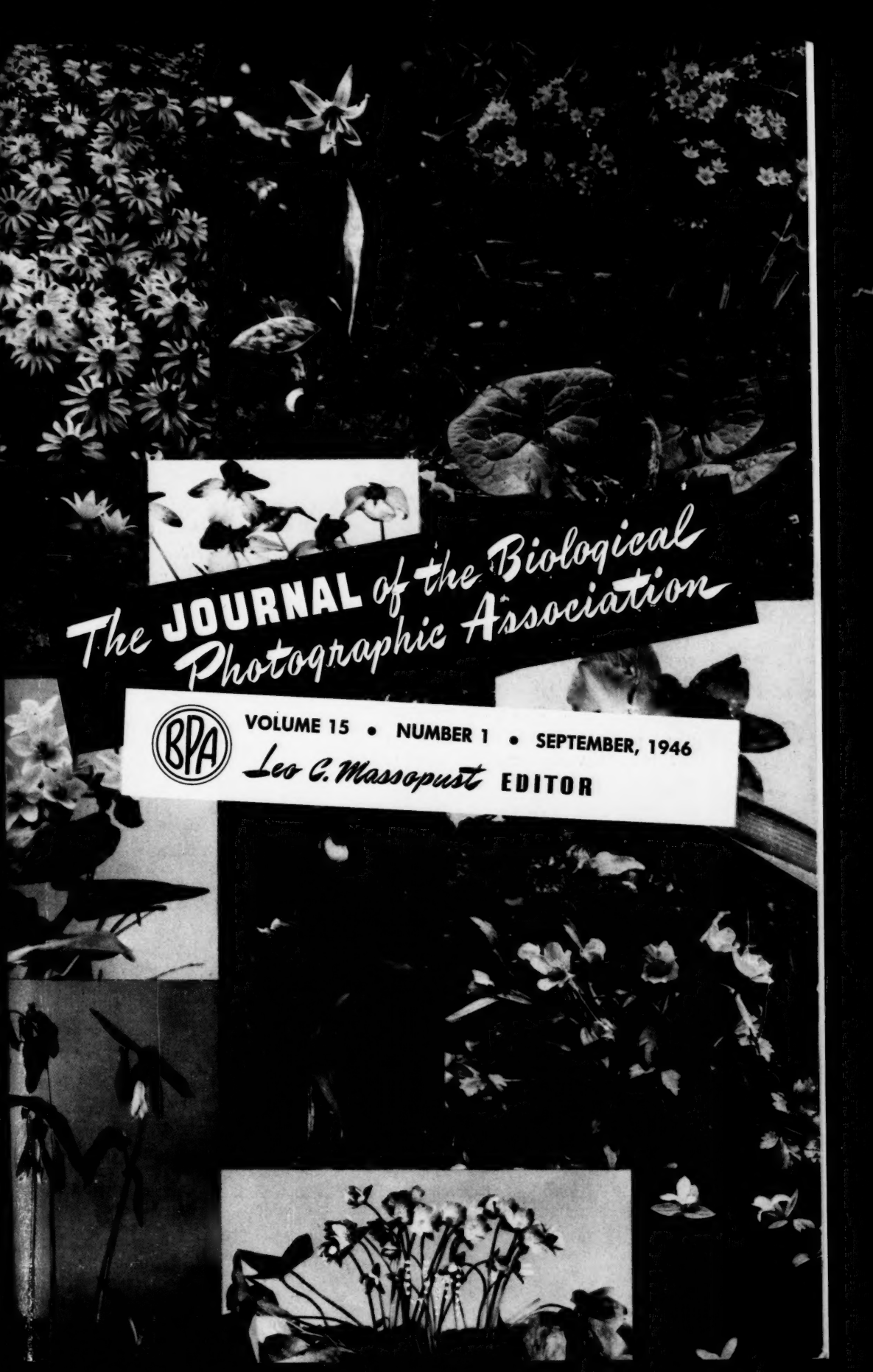

The JOURNAL of the Biological Photographic Association

VOLUME 15 • NUMBER 1 • SEPTEMBER, 1946

Leo C. Massopust EDITOR

Our New Cover

CHARLES W. COLLINGS

Now, before reading this, turn back, and take another look at our new cover design. And then doff your hats to one of our new members, Mr. Charles W. Collings of Danville, Illinois. Flowers and flower photos are his hobby—and this combination has made possible an outstanding contribution to Nature Photography, and to our magazine.

One can easily imagine the patience and technical ability necessary to produce such results. I can just see him down on his knees, in the garden dirt, with the trusty Speed Graphic, short tripod, and movable backgrounds, "sweating out" a picture.

The printed cover pictures can hardly more than suggest the excellent photographic technic and texture present in the originals. Look at the reproduction of the Black-eyed Susan in the upper left, and moving down, to the Bloodroot, Marsh Marigold, and Bellwort. Start at the top again with the fine specimen of Dogtooth Violet and Birdfoot Violet. The Yellow Lady Slipper never posed for a better picture—and the Hepatica in the bottom center is a most natural group. At the top right you have another Marsh Marigold and proceeding downward the Wild Ginger, Spiderwort Lily, Buttercup and we finish with the appealing Dwarf White Trillium.

We sincerely recommend that our convention Salon Chairman drafts "Charlie" for a One Man Show of flower pictures at a future convention of the BPA. "Charlie" also owes the Editorial Office a bouquet of these flowers for their part in choosing and effectively arranging the pictures comprising this beautiful cover.

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The JOURNAL of the Biological Photographic Association

Volume 15 • SEPTEMBER, 1946 • Number 1

Official Publication of the Biological Photographic Association

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Leo C. Massopust, Editor

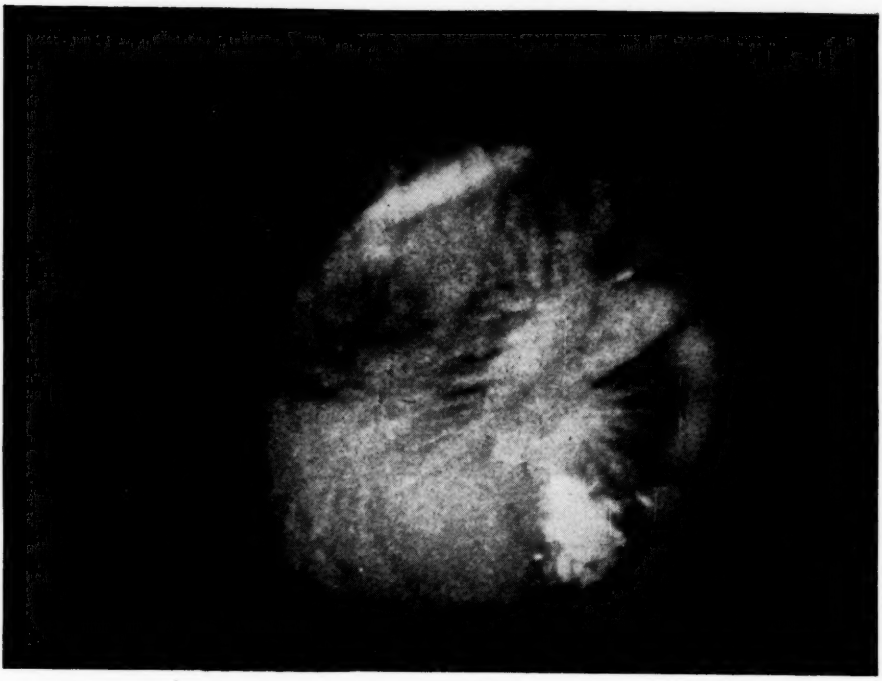
Marquette University School of Medicine

Milwaukee 3, Wisconsin

A S S O C I A T E E D I T O R S

ARTHUR W. PROETZ, M.D., Beaumont Building, St. Louis, Mo.; ANNE SHIRAS, School of Medicine, University of Pittsburgh, Pa.; FERDINAND HARDING, The Children's Hospital, Boston, Mass.; and ARTHUR W. FUCHS, 164 Inglewood Drive, Rochester, N. Y.

Published Quarterly at 561 North 15th Street, Milwaukee 3, Wisconsin. Entered at the Post Office, Milwaukee, Wisconsin, under the act of March 3, 1879. Subscription price $3.00 per volume; foreign countries $3.50. Single copies 75 cents in U. S. A.



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Ear-Drum and Macro Cinematography in Kodachrome

Mervin W. LaRue* and J. D. Brubaker†

THE purpose of this article is to describe apparatus designed and developed specifically for cinematography of the ear-drum and ear-canal, using 16mm Kodachrome color film. Pictures taken with the apparatus are sharp enough so that single frames from the motion picture film can be enlarged for use as still pictures.

Owing to the expense involved in developing this apparatus, and the limited application of a unit designed for a single purpose, it was thought advisable to adapt the design of the apparatus for use in other branches of macrocinematography, where this could be done without impairing the primary function of ear-drum photography.

The fundamental problems encountered in cinematography of the ear-drum and ear-canal, make this one of the most difficult of all endoscopic areas to photograph. The ear-canal is not straight, and in many persons it is so small in diameter as to make it extremely difficult to secure satisfactory pictures. Furthermore, the ear-drum diameter is larger than the ear-canal. The shape and position of the ear-drum, at any angle to the axis of the ear-canal, requires a relatively large depth-of-focus (6 to 8mm) in order to have all visible parts of the ear-drum in focus at the same time. For best results it is necessary to use the largest possible ear speculum—in most cases not smaller than 6 mm diameter. In spite of these limitations, a reasonably complete catalogue of films of many common types of pathology can be obtained by proper selection of patients to be photographed.

Received for publication July 16, 1946.

* Medical Motion Pictures and Illustration, 159 E. Chicago Ave., Chicago 11, Illinois.

† Design and Research Engineer, 805 Greenleaf St., Evanston, Illinois.

LEGEND FOR FRONTISPIECE

Right Ear-drum. Black and white reproductions from single frames of 16mm Kodachrome, 10 times original film size. When the page is held at arm's length, the magnification (5X) and appearance is the same as a projected image on the motion picture screen. Some detail has been lost since fine detail in the original depends upon subtle shadings of color which are lost when copied in black and white. A single frame is .284 by .380 inch. Both pictures made through a 6mm diameter ear speculum. (a) original film taken at 1.00 ratio (life size), (b) original film taken at 0.75 ratio.

The purely photographic problems are as follows:

(1) To illuminate the ear-drum and ear-canal with a high level of light intensity of proper color-temperature (3450K)—without excessive heat.

(2) To provide a relatively high degree of magnification (approximately 1 to 1) on the film.

(3) To provide means for supervising the field and focus while the pictures are being made. Special methods of focusing the camera are required, since at 1 to 1 ratio the lens cannot be moved in relation to the film in order to focus the camera.

(4) The camera lens aperture must not be very much larger than the ear-canal diameter. If the lens aperture is larger, the edge of the field will be vignetted due to the masking action of the ear-speculum at its smallest diameter.

(5) The problems in technic primarily consist of immobilizing the patient's head in relation to the camera, together with facilities of sufficient flexibility to permit alignment of the ear-canal with the camera axis.

These problems have been solved successfully by the apparatus described below. The range of magnification ratios of film image to object size was chosen to provide for an additional diversified use in macrocinematography where less than 1 to 1 magnification is often required.

Figures 1, 2, 3, show the general plan of the apparatus. The mechanical arrangement of the unit provides for the support of light-source, condenser lenses, 45 degree mirror, camera, and focusing telescope, all mounted on a half inch alluminum alloy base about 5 by 12 inches. This base has two ¾ inch diameter rods attached below it which ride on eight ball bearings, giving a smooth frictionless motion along the camera axis for focusing. Adjustable friction on the focusing knob shaft holds the camera base wherever it is stopped. The focusing knob, with rack and pinion, moves the whole assembly through a range of 2½ inches (6.3cm) to focus upon the area desired. The focusing motion also can be used for scanning the ear-canal by bringing into successive focus the various areas that are to be shown.

The magnification ratios of film image to object size were designed to be 1 to 1 (life-size), ¾ life-size, and ½ life-size. This provides rectangular field areas at the object plane of approximately .284 by .380 inch (7.5 x 10mm), .380 x .500 inch (10 x 13mm), and .568 x .760 inch (15 x 20 mm) respectively. At 1 to 1 and at ¾ to 1 ratios, it is possible to show fine details as small as .002 inch (.05 mm). On Kodachrome test films, for example, it has been found possible to

show clearly such details as finger print ridges on the finger, papillae of the tongue, and the very fine hairs (.002 inch in diameter) found at the entrance to the ear-canal. The films of the ear-drum clearly show the radiate fibrous layer of the drum membrane, the radial lines being very prominent.

The projected motion picture image, on the screen, simulates the appearance of the drum-head when directly examined with a 5X mag-

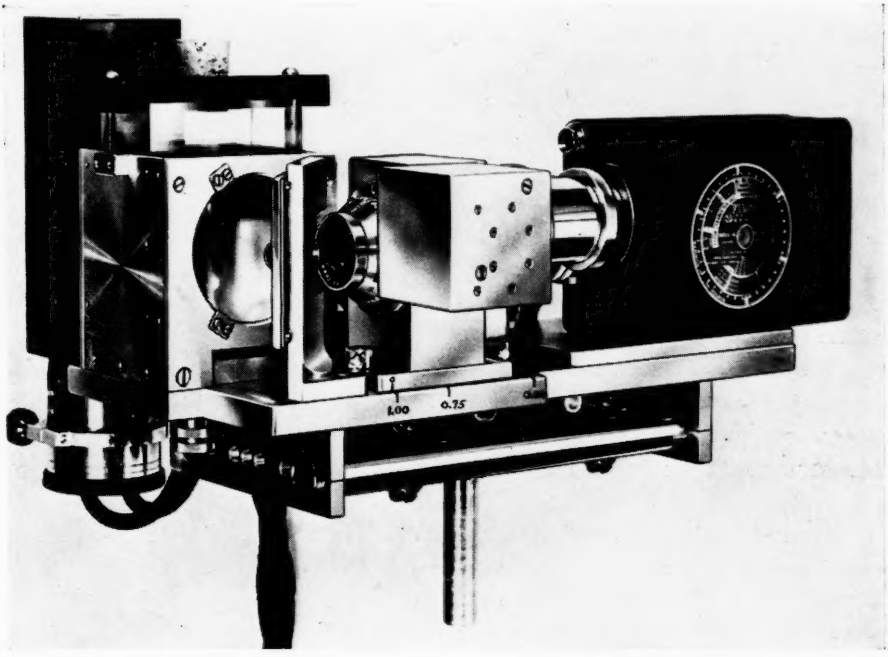

Figure 1. General view showing lens blocks, rods, and ball bearings.

nifier.[1] This degree of magnification brings out all the significant detail which can be seen in a visual examination of the ear-drum.

The components of the optical system and camera will now be described separately. Other details of construction also will be given to explain the basic design of the apparatus. Figure 4 shows the optical and photographic arrangement of the parts. Figure 5 shows the electrical circuits and the camera control method.

The light-source is a 6 volt 18 ampere ribbon filament lamp, operating at 6 volts for focusing, and at 8 volts while taking the pictures.

[1] The following analysis of magnification is based upon the angle subtended by the image, at the eye. For films originally taken at 1 to 1 ratio, and projected with a 2 inch focal length projection lens (normally supplied on 16mm projectors), the image on the screen will appear to be enlarged five times life-size for persons seated near the projector. For persons seated at a point half way from projector to screen, the enlargement will appear to be 10 times. For films taken at 0.75 ratio, the enlargements are 3.75 and 7.5, respectively.

The 2mm wide tungsten ribbon filament is focused by means of the condenser lenses upon the object plane. A 5mm wide image of the filament is produced. The lamp-house is movable in relation to the condenser lenses, and thus provides for about 1 inch (25mm) range of adjustment of the image at the object plane (to or from the plane of sharp camera focus). For surface macro-photography, the projected filament image is placed in the same plane that the camera is focused upon. At the lower magnification ratios, the image is thrown out of focus to illuminate a wider band of the object area. For ear-drum photography, the filament image is placed at the small end of the cone-shaped portion of the ear speculum. The speculum is polished and nickel-plated inside, to reflect maximum light into the ear-canal and onto the ear-drum.

The motion picture camera box is a Bell and Howell Auto-Load type. It uses magazine loading type A Kodachrome 16mm film, and runs about 12 feet at one winding. When operated at 16 frames per second, the shutter speed is 1/43 second. The camera operates through a hole in the 45 degree mirror. A 75mm focal length f. 4.5 Projection Ektar lens is used at double extension (for 1 to 1 ratio), to project the image of the ear-drum to the photographic film. The maximum marked f. stop which is usable is f. 8 (.350 inch entrance pupil diameter).

A beam-splitter cube, immediately behind this camera lens, diverts five per cent of the light to the erecting system and eyepiece of the focusing telescope. The remaining light forms the image on the photographic film.

A duplicate of the film image is produced at the telescope eyepiece. The eyepiece is a wide field type, of special construction, of 0.7 inch focal length (15X). The aerial image is used for focusing; no ground glass screen is used, because the low-contrast image of the ear-drum cannot be seen clearly enough on the ground glass for accurate focusing. The image in the telescope is seen erect and correct from side to side, the same as when looking directly into the ear-canal. This erect image is valuable since it facilitates rapid adjustment of the camera and ear speculum, without being confused by a reversed image.

Extension tubes of exact length are used at the telescope eyepiece, and at the camera, to provide the correct spacing of lens-to-film and lens-to-eyepiece for each magnification ratio. (Three pairs of tubes are required). The three fixed magnification ratios (previously mentioned) of film image to object size are: 1.00 (life-size), 0.75, and 0.50 (½ life-size). The lens supporting block, and camera box spaced by its extension tube, are moved to pre-marked positions on the base,

and clamped down. This maintains the object plane of sharp focus at the same distance ahead of the 45 degree mirror for all magnifications, and in correct relation to the converging beam of light from the condenser lenses.

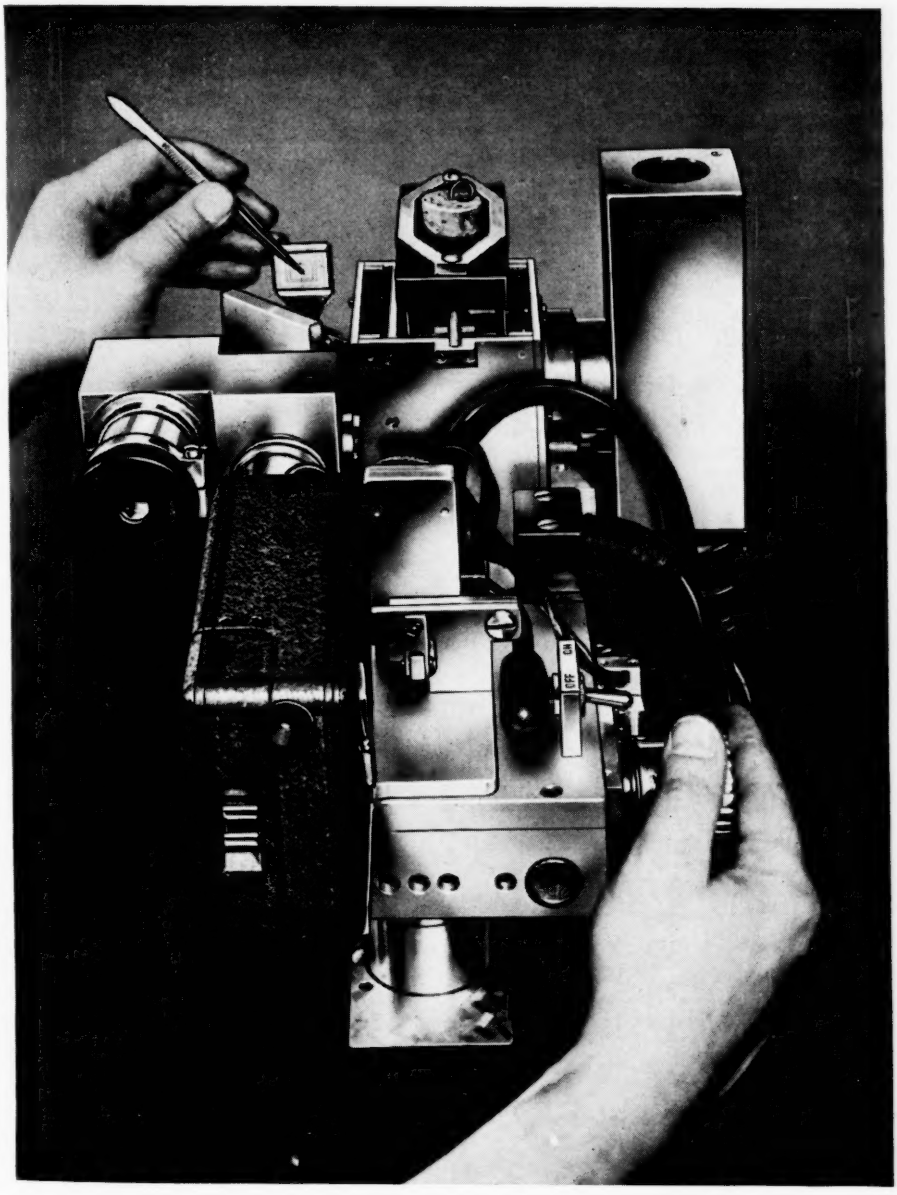

Figure 2. Rear view of camera showing focusing target used to align lamp.

A heat-absorbing water cell, and also a heat-absorbing 2mm thick glass (similar to the Corning Aklo No. 3966) are used between the condenser lenses, to reduce the heat at the object plane to a safe and comfortable level. The heat-absorbing filters are absolutely necessary, since without them, the high temperature at the object plane would undoubtedly damage the delicate membrane of the ear-drum and ear-canal. The total heat absorbed is about 85 per cent.

The illumination level at the object plane is about 650 candles per square foot reflected light, Weston. This corresponds to 1/40 second at f. 16 for type A Kodachrome (speed 12) film, when the lens is focused at infinity. Since the lens is used at double extension (1.00 ratio), the actual value corresponds to 1/40 second at f. 8 marked aperture. These figures are for 16 frames per second which is silent speed on 16mm film. A ratio of 0.75 requires a lens setting of about f. 9.5. A ratio of 0.50 requires f. 11, one full stop less than 1.00 ratio.

The camera release button is controlled by a small 26 watt solenoid operated from 115 volts a.c., Figure 5. A beveled ring attached to a snap-action switch lever is located about one-half inch behind the focusing knob, so that the camera can be focused, started, and stopped with the right hand, without removing the hand from the knob. This control ring operates the switch, and only a few ounces pressure by the thumb is required to operate it. The relay, Figure 5, operated by this switch, raises the lamp voltage to 8 volts, and starts the camera by means of the solenoid electrical control. When the ring is released, the lamp is switched back to 6 volts to conserve its life, and the camera stops. The action is instantaneous.

This arrangement gives automatic interlocking control of the lamp voltage and camera starting, and insures that no pictures will be taken with the light at the wrong color-temperature and low intensity. The rapid and convenient operation thus provided is necessary, since small unavoidable motions of the patient in relation to the camera may cause the camera image to go out of focus if there is too great a delay between focusing and operating the camera. With constant supervision of focus by means of the telescope, instantaneous decisions can be made as to starting and stopping the camera, or corrections in focus can be made while the camera is running.

Technic

The patient's head is steadied by the head-rest of a dental chair or equivalent support. The camera is mounted on an Eyemo heavy-duty, free-head tripod tilting top, adapted to a special adjustable stand to permit free motion in all directions—even laterally. It is important

to have a very sturdy support for the camera, since lateral motions between camera and ear-canal are greatly magnified on the screen when the films are projected. A camera motion as small as .002 inch can be seen.

Various parts of the ear-drum or ear-canal can be brought into sharp focus while the camera is running. This may be necessary be-

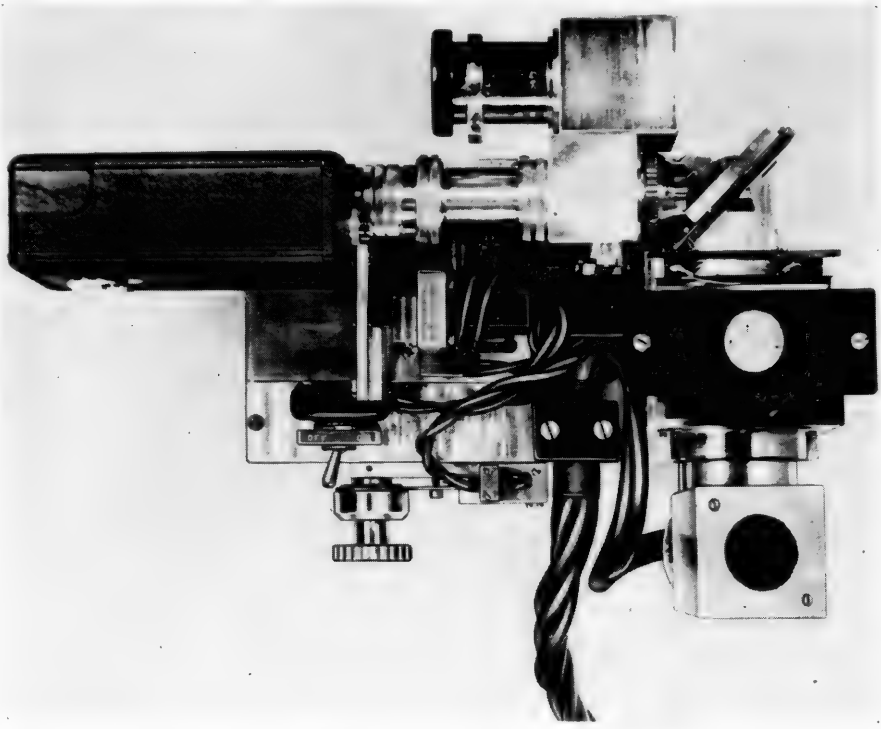

Figure 3. Top view of camera. (Corresponds to top view of optical system in figure 4.)

cause the depth-of-focus at the object plane is very shallow. At 1 to 1 ratio it is only about plus or minus 1/16 inch (1.5mm) for a film image with maximum circle of confusion of .003 inch (0.08mm). At 0.75 ratio, the depth-of-focus is about twice as great (plus or minus ⅛ inch (3mm)). A ratio of 0.75 appears to be the optimum for proper balance between size of film image and depth-of-focus. It is obvious that the smaller film image at 0.75 ratio produces greater depth of focus, since the lens-to-object distance has been increased.

There are two fundamental methods of aligning the ear-drum with the camera axis. (1) The patient's head is immobilized in a dental chair or equivalent support, and the camera is moved laterally and

vertically until the axes of the ear-canal and camera are aligned. The ear speculum is manipulated by the operator's left hand, and the camera is focused and controlled by the right hand. (2) The ear speculum can be mounted in a sleeve which slides in a tube rigidly fixed to the front of the camera base. This method keeps the ear-speculum aligned with the camera lens axis, and also allows motion of the camera unit in order to focus upon the ear-drum. The speculum can be kept fully inserted into the ear-canal while focusing.

Method No. 1 above, is required for taking pictures of the ear-canal wall near the entrance. In this case, no speculum is used, and the camera axis is placed at an angle to the ear-canal axis. The image of the lamp filament is focused upon the same object plane as the camera.

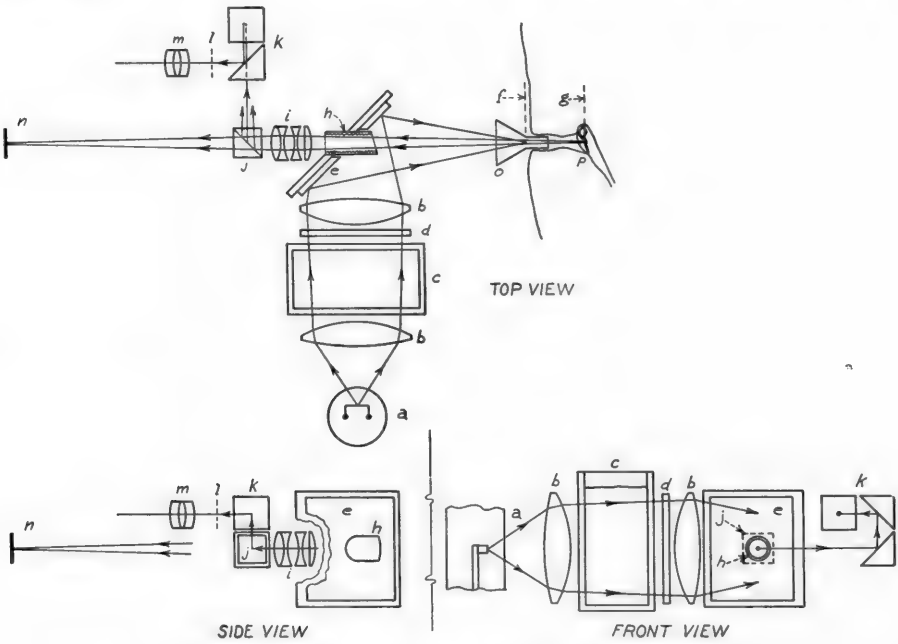

Figure 4. Optical drawing of camera (diagrammatic).

a—Ribbon filament lamp
b—Condenser lenses
c—Water cell
d—Heat absorbing glass
e—Mirror
f—Image plane of ribbon filament
g—Plane of sharp focus at object
h—Tube through mirror
Tube is threaded on inside
i—E.K. Projection Ektar lens f.4.5 of 75mm focal length. Maximum aperture f.8
j—Beam-splitter cube to divert light to telescope focuser
k—Front-surface mirrors which erect image in telescope
l—Image plane of eyepiece
m—Eyepiece lens of telescope
n—16mm motion picture film in camera
o—Ear speculum
p—Ear-drum. Note: Ear-drum section is shown rotated 90 degrees from true position

Since the ear-drum is larger in diameter than the smallest portion of the ear-canal, a lens cannot take a picture of the whole drum-head at one time. With constant supervision of field and focus, it is possible

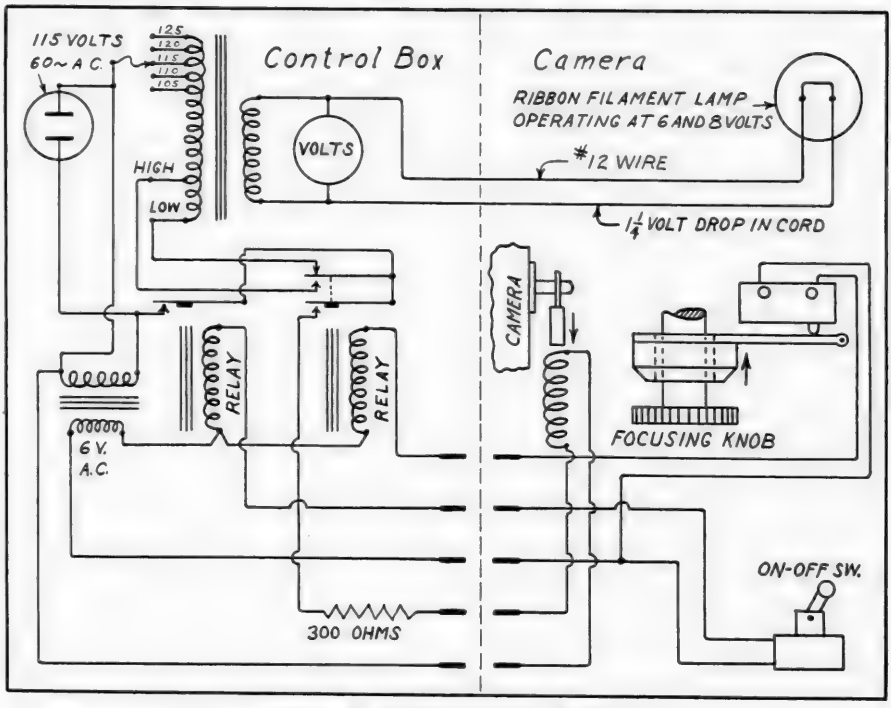

Figure 5. Electrical control circuits.

to manipulate the ear speculum to allow successive areas of the ear-drum to be photographed. The procedure duplicates the scanning method used in a visual examination of the drum-head, and the finished motion picture provides a very realistic illusion of actually examining an ear. The scanning procedure produces an illusion of perspective in the image which enhances the appearance of a simulated actual examination. Scanning the ear-drum in this manner builds up an image of the complete ear-drum in the mind of the person viewing the picture, and this valuable expedient has proven of much value in other fields of endoscopic cinematography.

Pictures without landmarks of some kind are of little value except where the nature of the pathology has obliterated the usual landmarks. The chief details most easily shown are: the fibrous tissue lines radiating from the umbo; handle of the malleus; and the reflection from the lower portion of the drum membrane known as the "cone of light". After first showing these landmarks, to give orientation to the image, the field can be scanned to show other details of the drum membrane.

Conclusion

The combination of light-source, camera, and focusing telescope mounted on one movable base provides the following valuable features:

(1) *The magnification is pre-set at a fixed ratio.* (If the lens is moved in relation to the camera, in order to bring the object into focus, the magnification ratio will depend upon how far away the object happened to be from the camera film plane. A change in magnification changes the effective f. stop value for a fixed diaphragm setting).

(2) *The illumination is pre-set for the proper intensity, and focused on the same plane in the object space that the camera lens is focused upon.* (When lamps are changed, the light value remains the same, because a ribbon type filament is used.)

(3) *The telescope focuser provides coaxial focusing and finding. An exact duplicate of the image recorded on the film is seen by the operator while the camera is running, as well as before and after the pictures are taken.*

(4) *By means of the system described above, the light intensity and f. stop setting are always known in advance, and the proper exposure for type A Kodachrome color film can be predicted wihin very close limits.* (The exact setting is originally determined from experimental test films made of a typical area).

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Naturalists Issue Directory

The current edition of Naturalists' Directory, Salem, Mass, $3.00 postpaid, will be issued September, 1946. It contains names, addresses and special subjects of study of professional and amateur naturalits throughout the world.. Published regularly for 60 years.

If you are a naturalist your name may be inserted without charge in the new issue.

A New, Improved Instrument For Color Photography

Its Use in the Associated Medical Sciences

Stanley J. Flesch

COLOR photography has become extremely important to the medical scientist. Until recently one of the important obstacles to universal use of color film was the inability to duplicate the colors as interpreted by the eye. Another was the inability to use color film under all light conditions, and the use of all types of color film under all conditions. Since color film can only record those colors which are inherent in the film itself, the manufacturers make the films sensitive to the various colors of light in different proportions, depending on the type of film and the conditions under which it is to be used. To assure consistently true color reproduction it is necessary that the color content of the light source be correct for the color sensitivity of the film being used.

For all practical photographic purposes all light, either natural or artificial, consists of three basic primary colors; blue, green and red, which are present in varying amounts. Daylight is ordinarily classified as white light, but actually consists of substantially equal amounts of blue, green and red. If the proportions of these colors were consistently equal to each other no problem would exist. But, because the color content of all light is in a constant state of fluctuation, some method is required which will first ascertain the color content of the light, and then correct the color content of the light for the color sensitivity of the film being used.

Since man first made fire by rubbing two sticks together and observed that certain types of materials burned with different colored flames, some hotter than others, it has been obvious that there must be some connection between heat and color.

As the temperature of any substance is raised, no visible color change occurs until the temperature reaches 800 Kelvin, at which point any material gives off a dull red glow. As the temperature is raised still further, the color changes from a dull red to orange-red. If the heat is increased even further, the substance would appear to be white at 5400 Kelvin and finally, the color of a blue north sky at 25,000 Kelvin.

This cycle of color change due to temperature runs through all types of direct light except fluorescent light, so that by measuring the color

Received for publication August 3, 1946.
230 S. Wabash Ave., Chicago, Illinois.

the temperature is known; or conversely, if the temperature is measured, the color is known. This system of measurement is called the Kelvin Scale or Kelvin Temperature, in honor of Lord Kelvin, the British physicist, who established the relationship between color and temperature by placing every substance available, such as iron, gold, silver, crockery, etc., into an iron tube and heating the tube until it was a dull red. On looking into the tube he was not able to distinguish the various objects which were made of different materials. They all had one thing in common—they were all of the same color. Even when the temperature was raised to the melting point of the tube, there appeared to be no difference in any of the colors of the objects within, indicating that all substances radiate exactly the same color at the same temperature.

Listed below are familiar recognizable color changes. Also indicated from 2400 to 9000 Kelvin are the steps in the color changes that are important photographically.

KELVIN SCALE FOR PHOTOGRAPHIC USE

Absolute Zero is 273° below Zero Centigrade

Kelvin Temperature is equal to Centigrade Temperature plus 273°

Iron Glowing Dull Red	800 K
Candle Flame	1850 K
Vacuum Tungsten Lamp	2400 K
Ordinary House Tungsten Lamp	2900 K
Projection Lamp	3200 K
Photoflood	3400 K
White Fluorescent Lamp	3500 K
Photo Flash	3600 K
Average Photo Flash	3800 K
Daylight Tungsten	4000 K
Early or Late Daylight	4300 K
Early or Late Daylight	4800 K
Daylight Photoflood	5000 K
Mean Noon Sunlight	5400 K
Sun and Sky	5900 K
Daylight Fluorescent	6500 K
Hazy Sky	8000 K
Blue Sky	9000 K

In both black and white and natural color photography, correct exposure depends upon the accurate measurement of the light reflected from the object, and the proper speed rating of the film emulsion being used. In addition, in natural color photography it is necessary that the color content of the light be correct for the color sensitivity of the film.

At every change in degree of Kelvin temperature, the color of light will vary, but at any given degree of Kelvin temperature, the color contents of the light is always the same regardless of the light source.

Figure 1. The Harrison Light Corrector Meter.

Because of this fact the color content of the light at each photographic step of the Kelvin temperature scale is important in taking color pictures.

The Harrison Light Corrector Meter measures the Kelvin temperature, and the 22 Light Corrector Discs correct the color content of the light for the color sensitivity of the film under all lighting conditions. This correction is accomplished by absorption of the primary colors in the light which are excessive in relation to the color sensitivity of the film.

If the three primary colors of light varied only in definite and specific amounts it would be simple to correct the color content of the light to the film color sensitivity. Although all light is composed of the primary colors, they blend together in thousands of variations which result in many different color combinations and many shades of the same color. Harrison calculated more than 22,000 possible light color combinations which might affect color pictures.[1] To control these possible combinations of light it would have been necessary to use thousands of light corrector discs. Now the number of light correctors necessary to control the color content of light has been reduced to 22 for all practical photographic purposes.

[1] Personal Communication.

With this set of 22 matched light corrector discs it is possible to control the color content of light for color film under practically all conditions. In other words, it permits use of daylight color film (Daylight Kodachrome or Ansco Outdoor Color), photoflood color film (Kodachrome Type A), and tungsten color film (Kodachrome Type B or Ansco Tungsten Color) under all conditions suitable for ordinary black and white photography.

Because the eye cannot accurately determine the color content of light it is not possible to select visually the proper light corrector disc to compensate for variations in Kelvin temperature. Frequently pictures taken under artificial light with a supposedly constant color content, do not have consistently true colors. The reason is that there are always variables present that will affect the color content of the light. These variations include fluctuating voltage, age of bulbs and colors of backgrounds. Therefore, even though taking pictures under a known light source that has a color content correct for the color sensitivity of the film, there is no assurance of consistently true colors in the pictures. These obstacles were overcome by the development of the light corrector meter which analyzes the color content of the light and selects the proper light corrector disc.

The Harrison Light Corrector Meter is a precision instrument that has been designed and constructed to determine the Kelvin temperature of the light source directly or indirectly. If the light source is not too brilliant a reading may be taken of the direct light disregarding the edges as the edges may give a false reading due to dust, dirt, optical refraction of the glass and so forth. If the light is so bright that looking directly at the light source is impractical, a special white reflecting card is used to obtain a reading of the incident light. After determining the reading in degrees Kelvin, the meter also indicates the light corrector disc which will correct the light for the particular type of film being used. Indicated on the reverse of the meter are all of the factors for the 22 light corrector discs. Also indicated for each disc is a system of increasing the diaphragm opening from normal to compensate for the exposure loss when using the discs.

This instrument may be utilized in many phases of scientific photography such as photomicrography, gross specimen photography, clinical photography, copying and in still, movie and flash work.

According to Mr. J. W. Crunelle, of the Department of Photography of the University of Chicago,[2] best results in photo micrography are obtained by placing the color corrector disc after the water cell and between the light source and the microscope. Using a ribbon filament bulb he reported no heat damage to the corrector disc and better color rendition in the subject.

[2] Personal Communication.

It is interesting to note that Mr. Crunelle uses a very sensitive photoelectric cell and galvanometer to determine the correct exposure without using the filter factor. He does this by taking his readings from the ground glass of the camera while the filter is in place between the light source and the microscope.

Mr. Crunelle has also photographed gross specimens using the Harrison Light Corrector with the result that his color rendition was closer to normal and much truer. This opens a wide field for experi-

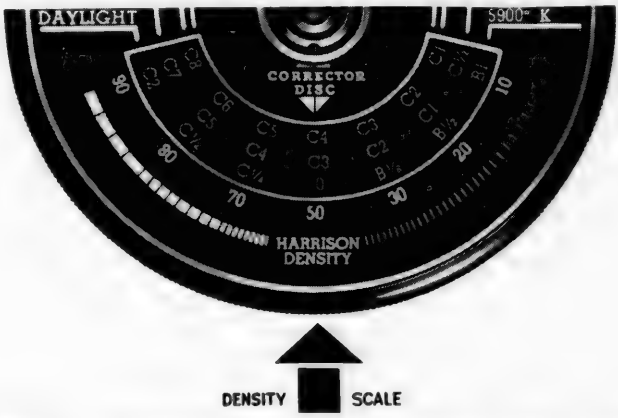

Figure 2. The Density Scale for Use in Controlling Color in Picture.

mentation for the biological color photographer because the matched set of 22 discs with which the light corrector is equipped provides an unlimited number of possibilities. He also photographed a model with a color chart as an integral part of the composition. Taking two pictures, one with the light corrector and one without, his results showed a day and night difference. The photograph taken without the aid of the light corrector showed a definite bluish cast and the colors in the chart did not reproduce in true rendition. In the second photograph in which compensation was made as indicated by the light corrector, the colors of the subject, dress, background and color chart were definitely truer and closer to normal given a much better rendition overall.

The density scale at the bottom of the Light Corrector Meter can be used to control the degree of color in the picture or as a means of compensating for differences in color resulting from visual and processing errors. For example, if the tendency of a particular film is always bluish, then the corrector disc to be used for the picture may be taken from any point above the one at the normal 50. A density below 50 could be used if the picture has a reddish cast. The exact density reading of course, can be determined only after photographic tests.

To make these tests a series of at least seven pictures should be taken in the following manner. The first picture should be taken with

the normal light corrector disc indicated above the density reading of 50. If the meter reading is the same as shown in the illustration, "O" is indicated for the light corrector disc to be used with Daylight Film. This means that under these conditions no light corrector disc is necessary.

When the next three pictures are taken, the light corrector disc indicated above the figure 70 should be selected for the second picture of the series. The third picture should be taken with the light corrector disc shown above 80, and the fourth with the light corrector disc that is indicated above 90. The last group of three pictures should be taken with light corrector discs B-⅛, B-½ and B-1. These are the discs indicated above density readings 30, 20 and 10 respectively. These test exposures will indicate the way in which the various light corrector discs will change or correct the degree of color in the pictures.

The test described above is a hypothetical example. When an actual test is made, the starting point is the light corrector disc indicated above 50 on the density scale, and below the arrow marked Normal Light Corrector Disc, when the proper meter reading has been made. The next six pictures are to be made with the respective light corrector discs indicated above and below the normal 50.

After examining the test pictures for the degree of color change caused by the light corrector discs other than the normal indicated disc, one can, by proper use of this range, control the degree of color in the pictures, or compensate for a bluish or reddish cast of the color picture caused by (1) differences in types of color film, (2) differences in laboratory processing, (3) differences in color film emulsion and (4) visual differences.

Thus, because of these differences or variables found in color film, it may be necessary to make occasional tests in order to determine the proper light corrector disc to be used under certain specific light conditions. When the proper disc for desired results is determined it is important to use consistently one type of color film in order to become familiar with all of its peculiarities. Whenever a different type of color film (daylight, tungsten or photoflood) is used, or a change from Eastman to Ansco natural color film is made, these tests can be repeated to familiarize one's self with the peculiarities of the individual film. Once these principles have been firmly grasped, one may be certain of consistently true color pictures under all possible light conditions by careful use of the Harrison Light Corrector.

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Medical Photography in the Army

M/Sgt. Stephen P. Dittmann

FROM the time of Pearl Harbor until the last gun of the war had been fired, Army war photographers and newsmen were at work wherever our troops were fighting, filming war in all its horror and glory. Millions of people gazed with awe at these dramatically graphic records of a world-wide conflagration. Of little fame, however, have been the no less dynamic records of the medical history of the war made by Army medical photographers.

The interim between the first and second World Wars saw the early development and advancement of medical photography. Many institutions began to realize the importance and tremendous potentialities of photography in medicine, and indeed a few centers developed it to a high degree of efficiency and perfection. But, in general, most hospitals and private practitioners were handicapped, both by a lack of trained personnel and by the fact that medical photography, being an aid to the institution rather than a service to the patient, was an expense to the former often not deemed prudent or necessary. With the advent of the war, the Army was quick to realize the importance and necessity of keeping graphic records of many cases; therefore they gave to medical photography a position commensurate with its value to medical science.

In the extensive use of medical photography the Army saw not only an aid to the doctors concerned with the particular cases in their study and prognoses thereof but also the opportunity for preserving for the future use of the medical profession in general, detailed pictorial information about unusual cases and new developments and technics evolved by the Army Medical Department, especially in such fields as neurosurgery, plastic surgery and paraplegia. These records are, or will be, available at the Army Institute of Pathology, Washington, D. C., for the use of any military hospital, federal or civilian institution requiring such information. During the early part of the recent war, qualified persons were selected and sent to the Army Institute of Pathology for further training in clinical photographic technic. From this group the MAMAS (Museum and Medical Arts Service) Detachments were organized. These Units were sent to the various Theaters of Operation and their chief duties were to prepare a pictorial record of all Medical Department activities.

Received for publication July 20, 1946.
Army Medical Museum, Washington 25, D. C.

Many difficulties were encountered in developing Army medical photography to its present point of efficiency. Of foremost importance was the procurement of sufficient adequately trained personnel. This, in itself, was an enormous undertaking, for the medical photographer must not only be trained in basic photography and laboratory technic, but also must have some knowledge of medical terminology, anatomy, aseptic technic, and many advanced forms of photography such as photomicrography, the correct use of infra-red, color and process films, motion picture technic, lantern slide procedure, and copying. Because of the pressing need and the lack of training facilities, many of the men thrown into the field had to acquire the bulk of this knowledge while actually on the job.

More difficulties arose in setting up laboratories. Each general hospital had to be equipped with a medical photographic laboratory, but most of these structures had to be temporary, and due to an initial shortage of equipment, much of the apparatus had to be improvised. This led to the designing and constructing of many gadgets (which may in the future prove of value to the medical photographer) as well as the adaption of many standard pieces of equipment to new and unusual usage.

The standard camera for all still work has been the 4 x 5 Speed Graphic. In addition to studio work this camera had to be adapted for use in the operating room, treatment room, autopsy room, wards and pathological laboratory. In the pathological laboratory a great deal of work has been done in the fields of photomicrography and the photographing of gross specimens. Of considerable importance in this work has been the use of transilluminated color backgrounds which have been of value because of the pleasing effects in the contrast attained. A comparatively new phase in medical photography is that of endoscopic photography and in this field some notable results have been achieved by the Army.

The regular use of black and white and color photography has been supplemented by infra-red. This field, too, is still in its infancy, but it has already proved to be of considerable value in the study of extremity gangrene and the establishment of the amputation level most favorable, the study of cases involving a congestion of the superficial venous system, and the study and diagnosis of eye conditions.

Army hospitals have put heavy demands on their medical photographers' time and skill in making lantern slides and in copying. Both of these processes require extreme accuracy. A great number of lantern slides in black and white and color have been made for visual aids supplementary to lectures and for exhibit purposes. Copies of

charts, graphs, electrographs, and radiographs have been made wherever the need arose, for the purpose of distribution or publication and have often formed an intrinsic part of the clinical case histories.

Cinematography has become more and more essential to medical photography. In instruction it is invaluable, for only through the medium of motion pictures is it possible to view, at any time, the details of unusual operations or the entire progress of a case through all its phases and over a considerable time. The Army has made extensive use of motion picture photography, especially where surgical technic has been of special importance in the case. The majority of the motion pictures taken of patient progress has involved a great deal of time between pre-operative, operative, and various post-operative scenes, and in such pictures the problem of preserving continuity and uniformity arose.

Motion pictures have also been used to record methods of reconditioning and physical and occupational therapy. All of these films had to be titled and edited by the medical photographer in his own laboratory. These films, as well as all stills, are on file in the Medical Illustration Division of the Army Institute of Pathology.

There has been a constant demand upon the Army medical photographer for exhibit material to use at medical conferences and in permanent displays. These exhibits, in the form of stills, slides and motion pictures, portray not only the work of the hospital or installation but also the ability of the photographer; therefore it has been essential that the men engaged in this work have some knowledge of museum technic.

Besides the branches of medical photography mentioned above, the Army has been utilizing various other forms. Among these are intraoral photography, steroscopic photography, cineradiography, and miniature photography. Photography has also become important to the dental and ophthalmological services. In addition, the Army medical photographer has been required to do public relations work as well as the photographing of equipment and its use.

Because of the stress placed upon it by the Army, medical photography has made tremendous advances during the war years. The extensive research in medical photography carried on by the photographic industry has been of valuable assistance to the Army and the photographic profession in general. With the impetus given it by the Army, medical photography is gaining a greater degree of recognition among medical men. Medical art has already been greatly supplemented by photography because of the speed and accuracy obtainable. With the advances in the black and white and color photography, medical mu-

seums have been able to replace many of their old-time, bulky specimens with pictures and slides which allow for a greater quantity of material to be kept in a given space. Moreover they have found this photographic material to be more attractive for display purposes.

Today, medical photographers, including those in the Army, form a small group of highly trained, skilled technicians. They look forward to the day when, through the recognition accorded them by such organizations as the Biological Photographic Association and the Technical Section of the Photographic Society of America, their work will occupy the place in medical science which it deserves. The time is quite near when all hospitals will be equipped with complete medical photographic laboratories and when all physicians realize the potentialities of photography in medicine. The medical photographic program in the Army has been and will continue to be a decisive factor in attaining that goal.

Book Reviews

AMATEUR PHOTOMICROGRAPHY WITH SIMPLE APPARATUS
by Alan Jackson, B.Sc., A.I.C. A Focal Press Book. Distributed by Transatlantic Arts, Forest Hills, N.Y. 160 pages, 5 x 7½. Twenty-four illustrations and 21 drawings. Paper bound. $2.25.

This book is intended primarily for the inexperienced photographer, emphasis being laid on apparatus which can be easily constructed by anyone handy with tools. It contains much basic information and many practical hints which are presented in a concise and orderly manner. It reveals that photomicrography is not only a highly specialized subject but it can be a very enjoyable hobby. The book is well illustrated.

Leo C. Massopust

LEICA GUIDE by W. D. Emanuel.
CONTAX GUIDE by W. D. Emanuel.
ROLLEIFLEX GUIDE by F. W. Frerk.
EXAKTA GUIDE by W. D. Emanuel.
Focal Press Books. Published by Transatlantic Arts, Forest Hills, N.Y. 112 pages each, 4¾ x 6½. Illustrations. Paper bound. $1.75 each.

These books are excellent camera guides. The author of each book describes the camera in detail and aims to submit information on how to take the best photographs with the camera in question. These guides follow the sequence of operations and contain a helpful index "How to . . ." On the back cover, the camera is depicted with all parts labeled.

They are not sponsored or censored by manufacturers, hence, the authors are unbiased and try to be fair to the camera and candid to the readers.

Leo C. Massopust

ERRATUM

The review of "Medical Photography" in the June 1946 issue failed to state that the book is a Focal Press publication distributed by Transatlantic Arts, Forest Hills, N.Y.

Wild Flower Photography

Charles W. Collings

HAVE you taken and retaken the pictures of your home, family, friends, and pets until it seems that there is nothing new under the sun to tempt your camera? Have you grown tired of the same subjects and wished for some new field to conquer? If so, why not take a trip to the fields and woods and notice the beauty of the flowers growing under your feet. As you observe the beauty and texture of the flowers and plants, you unconsciously avoid stepping on them and examine them more closely as you become fascinated with their tantalizing shapes and colors. You finally realize that here is something that you and your camera can bring to your family and friends, the beauties of nature of which there is an ever changing display and a sufficient number to last and tempt your ability for several years. As you find new flowers unknown to you, your interest grows and as you read and study, the hobby takes on new pleasure and you can hardly wait for the next outing.

The old saying "April showers bring May flowers" may be correct, but do not wait for May or even April to start picture-taking of nature's beauties. The earliest flowers are waiting only for the first warm days, whether it be February or March. The first of the earliest is the skunk cabbage, and while not as showy in color as some, it is a good subject, and gives several good pictures, from its first shoots to its giant elephant ear-like leaves later in the season. Almost as early are the dwarf white trilliums and hepaticas. In early March the white petals of the trilliums were dotting the hillsides and the hepaticas were pushing their hairy stems upward through their leafy covering only to be covered with snow. The sun soon had the snow cleared away and the flowers were as bright as ever.

All these flowers are only waiting for you and your camera, but they must be taken within a short time as they are gone by the first of April. The blood root follows closely as do dutchman's breeches, pepper root and crinkle root. The blood root is good for several pictures, but it must be taken within a few days. Its flower stem pushes upward completely encircled by the leaf which opens exposing the delicate white petals which seem to drop at the first touch or breath of wind. The dutchman's breeches are a reminder of the old fashioned bleeding heart only white in color.

Received for publication April 17, 1946. Danville, Illinois.

It is impossible to list all the flowers as they appear in rapid succession and it seems like a race to get back to the wood to catch them before they have gone. Different flowers grow in different locations, one hillside being covered with one variety, another on the next never mixing, while on some you will find several growing together. Next season when you feel that you can make a better picture of one of your beauties, you will find it growing in the same location.

The many varieties of violets, blue, white, yellow, growing everywhere, the dog tooth in swampy ground and the bird foot growing on sunny exposed hillsides are early bloomers and are also good pictures.

Two water loving, early bloomers are the marsh marigold and swamp buttercup. The beautiful odd shaped rare lady's-slipper makes its appearance the last of April or first of May. Its beauty calls you year after year and as you have seen flowers so wantonly destroyed, very likely you will keep its location a secret letting your pictures bring its beauty to your friends.

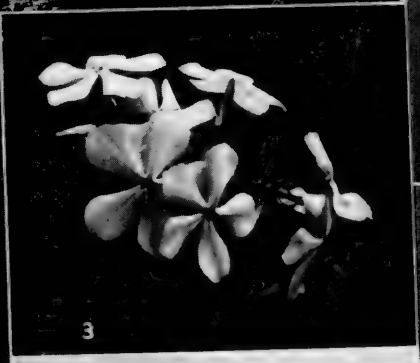
So it goes the year round, the earliest flowers being smaller and more delicate than those of the late summer and fall, but they offer a challenge to your ability to show them as delicate and beautiful as they really are. If you were as deeply impressed with the desire to take pictures of these beauties of nature as you were to try your camera the first time, many pictures have been taken by now, some good, some not so good, but the desire to store your camera has not returned and the determination to make better pictures has increased.

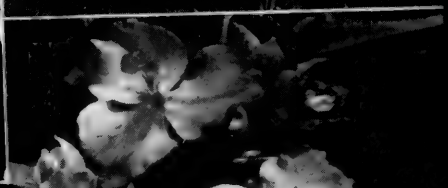
Figure 1. Black-eyed Susan.

Make your flower pictures with whatever camera you have, but make them. However, you will find that no one camera is best for every subject and as flower pictures must necessarily be taken close up, if your

LEGEND FOR OPPOSITE PAGE

1. May apple. 2. Milkweed pod. 3. Wild phlox. 4. Shooting star. 5. Milkweed. 6. Sneezeweed. 7. Mushrooms. 8. Spiderwort Lily.





camera does not have an extension bellows and ground glass, it will be necessary to use an auxiliary lens or portrait attachment and measure distances accurately. A camera with an extension bellows and ground glass will permit close accurate focusing and better composition. As large a picture as possible should be composed on your negative as a flower picture without sharpness and texture is a failure. As you get closer to your subject the depth of focus decreases so it becomes necessary to use as small a stop or lens opening as possible. This usually requires a long exposure.

After a few trips to the woods, you will find that a few accessories will make your trips more of a pleasure and the results will be more to your liking. A good steady tripod is a necessity, not too large, a tilt top, as you will be working mostly on uneven ground and the camera should be level, almost if not quite on the ground so as to prevent foreshortening of the subject. You will find too, that the wind is blowing continually or so it seems and though you can scarcely notice it, all you have to do is watch your flower and you find it is still but a very short time. Here is where some sheets of cardboard or cloth come in handy as wind breaks. A knife to cut some sticks and spring clothes pins to clamp the cardboard or cloth to the sticks will be other musts. A garden trowel is also a handy tool to carry. All these weigh little and may be carried in camera case with the exception of the cardboard which I carry rolled up, slung over my shoulder.

Figure 2. Yellow Lady Slipper.

After selecting your plant, a little arranging and clearing away of leaves and sticks will make a better picture, but you should disturb the plant as little as possible. A little dirt or moss placed in the plant or against a flower will at times make a better composition and bring flowers nearer the same plane or change the view of the flower without being noticeable.

Pictures taken on hazy days are more evenly lighted, but if sunshine is a must, the plant

Figure 3. Nodding Lily.

should be screened but from a distance. If taken in full sunshine the picture will be too contrasty, and after a few trips you will say "Never again". As the light is very deceitful in the woods, an exposure meter is a necessity. Hold your meter close to the flower, but do not shade it and give the exposure according to the reading. Don't try to out-guess your meter. If you doubt whether the flower was still during the exposure or whether you can return for another try if the picture is not good, better make more than one exposure. When taking pictures on hilly ground, use the hillside as a background, but be sure to remove any light colored objects as they make distracting spots on the picture. If you wish a plain background and cannot take the flower home, dig a trench back of the flower with your trowel and use one of your cardboards as a background, but be sure your camera is on the level of the flower so you won't be looking down on the dirt back of the flower or you will have a picture of the flowers and not of the entire subject.

As you make more pictures in their natural habitat, you find yourself wanting to see what you can do indoors by artificial light. As most of the early flowers are small in size, they can be carried home earier than the ones later in the season. Some plants can be moved easily without wilting or losing their leaves and flowers while some wilt at once and will not straighten up. When you find one of the latter you may yet be able to take the picture if you dig the plant while the flower is in bud, and let it bloom after planting in your studio. The flower should be dug with a large clump of dirt, disturbing the roots as little as possible and placed in carrying box or basket, well protected from wind and sun and taken directly to where they are to rest and revive. Even though the flowers wilt, if the dirt is well watered, in a few hours most of them will straighten up and be in good condition. If the picture is made without a chance for complete recovery, the pictures may show some movement and loss of detail even though

the movement of wilting and recovery is too small for the eye to distinguish.

My pictures are taken in the basement where I have built a table 30 inches high, 30 inches long and 18 inches deep on which I have built a frame eight inches high on back and sides, with front open. This frame is filled with dirt, sloping up from the front about eight inches, the top being level. I have covered the front and a few inches of the top with moss. It is not too smooth but as near nature as possible. If you keep the dirt damp, the moss stays green and grows and makes a natural setting for planting your flowers on the level top. When plants are brought from the woods, they are set out in the top, well watered and allowed to recover. A rest over night will usually give you a plant as fresh as in its natural surrounding. Next comes the background. I have found oilcloth makes an excellent background. You buy it for the color of the back, not the front. Cloth with white or light yellow back gives good light backgrounds, while light green will give good grey or black according to the lighting. For a more natural background, I have built a shallow box, about four feet square, filled it with dirt about one-one half inches deep, covered it with moss, a few dark stones and pieces of bark. This background is sloped up back of the plants. Your camera should be on the level of the top of your planting table so that you will not have a break where the background begins. Photofloods are used to give lighting desired and when taking single blooms or large ones standard lighting is used. In making pictures of small flowers where there are several flowers and leaves, I use one photoflood and wash the light over the setup. After focusing on the nearest flowers, I stop the lens down to the smallest opening to secure as much depth as possible, then close the shutter setting it on time. I remove holder slide, turn off lights and prepare to take the picture. You will find that having a regular place for the light so that it can be picked up in semi-darkness comes in handy. While the room is in darkness, open shutter, take your light and from a low angle, I crouch down, expose background for the tone you desire, here you will learn by experimenting. As the background is placed a short distance behind the subject, you can light it from a low angle, back of the setup without exposing the subject. If back lighting is desired, while in position for background lighting you can change direction of the light and direct it on the subject for a short time. As light is moved back and forth it does not expose as much as you might expect. After exposing background turn off light, come back in front of the plant, turn on the light and expose from the near side, front, opposite side, top and foliage. As foliage and foreground will require more light, the reflector is tipped so that light is directed on them for a few seconds additional. When you

have made the exposure, turn off the light, close shutter, turn on room light and replace slide. Your first picture will be by way of experiment, usually requiring 15 to 20 seconds, depending on the speed of film and closeness of the light to the subject. I work just back of the camera in lighting the subject, walking from side to side, lighting as I walk. You will be surprised at how few failures you have and in a short time it will not be necessary to make test exposures. When moving from side to side, move carefully and if working on a cement floor, you will not jar the setup. When first trying this exposure, you will have many doubts as to the length of exposure, but try a couple and develop the film leaving your setup for further use if necessary, but I'm sure after a few trials, you will waste few films. As the season progresses and woods grow almost impassable, more flowers will be taken indoors or into open fields using artificial backgrounds. However, everyone to his liking, natural habitat or artificial surroundings. You will have followers in which ever field you choose and many if you choose both, but whatever you do, make a start and the pleasure will be all yours.

Mortimer Cohen, M. D.

Dr. Mortimer Cohen, Associate Professor of Pathology at the School of Medicine, University of Pittsburgh, and Pathologist to the Magee Hospital, died suddenly of a coronary on June 20th at the age of 49. A skillful photomicrographer, Dr. Cohen was also intensely interested in the general application of photography to the teaching of pathology. He was very much against the indiscriminate photography of large numbers of specimens and patients, contending that photographs must be carefully chosen and integrated into the lectures for which they were intended. Having once chosen the material which he believed best for the illustration, nothing was too much trouble in preparing it for photography. The preserved specimens that came from his laboratory were always fixed thoroughly and full of color. His sections were invariably well-stained; one modification of a Mallory stain that he worked out was particularly well adapted for color photography. He put as much care into the collecting and presentation of illustrations for routine classes as is usually reserved for spectacular exhibits at large meetings. This care and enthusiasm made him a stimulating teacher and an inspiration to the photographers and technicians who worked with him.

Dr. Cohen was Chairman of the Pittsburgh Chapter of the B.P.A. for one season, and in spite of the many demands made on his time by his medical duties, he presented several programs on photomicrography at the meetings.

Sixteenth Annual Convention

The 1946 convention in Chicago takes shape with the headquarters moved from the LaSalle to the Bismarck Hotel and the dates changed from September 5, 6 and 7 to September 6, 7 and 8. The Bismarck is reserving 30 double rooms for those who make reservations through the Office of the Secretary, Miss Anne Shiras, University Office, Magee Hospital, Pittsburgh 13, Pa.

The Scientific Exhibit being arranged by Nat Horton, New York City, and Charles Lindsey, Chicago, includes as special attractions, the material of Doctors Paul Holinger and Galloway.

An official luncheon has been planned for Friday noon. On Saturday, Eastman Kodak Company will entertain at a cocktail party preceding the Annual Banquet at which Morris Fishbein, M.D., Editor of the Journal of the American Medical Association, will be the guest speaker.

The first group of Fellows will be announced during the convention.

The program includes *Let's Make a Medical Motion Picture* by Mervin LaRue and Richard W. Kleidon; *Present Day Uses of the Motion Picture,* Warren Sturgis; *The Visual Education Program at Northwestern University School of Medicine* by Evastine Lust. Other familiar speakers will be John A. Maurer talking on *Color Balance in Photomicrography;* Oscar W. Richards, *Phase Photomicrography;* and H. L. Gibson, *Kodak Dye Transfer Process.*

A title has not been determined for the paper to be presented by the U. S. Navy Bureau of Medicine and Surgery but Major Carrol Naidorf of the Army Institute of Pathology will give a paper on *Classifying, Indexing and Filing Medical Illustration Material* which is to be discussed by Edward N. Hamilton, Los Angeles, and Edna K. Kauffman, Chicago. *The Medical Illustration Program of the United States Veterans Administration* will be presented by C. Graham Eddy.

Well-known Chicagoans on the program will be Paul Holinger and J. D. Brubaker, *Endoscopic Photography of the Ear, Nose and Throat;* Thos. G. Hull, Director of Scientific Exhibits for the American Medical Association, *The Preparation of Scientific Exhibits;* Charles Wilson, Director of the Chicago Police Scientific Crime Detection Laboratory, *Photography as Applied to Crime Detection.*

Irving Rehman, Los Angeles, will speak on *High Speed Xray Motion Picture Studies* and G. L. Royer and C. Maresh, Bound Brook, N. J., will present *Color Photography of Fluorescent Phenomena.*

Amplifying Lenses for Biological Photomicrography

With Remarks on Oculars, Objectives and Condensers

Albert Sadler

IN photomicrography there are three distinct and separate lens-elements within the microscope which operate together, namely: the ocular, objective, and condenser. They must have the same degree of optical corrections, for the definition of the final image can never be better than the definition produced by the lens of the lowest correction. What optical equipment is essential to good photomicrography? Just what constitutes good photomicrography? Leaving the personal equation of the photographer out of the question, one knows that lens-systems with the greatest degree of optical correction are capable of the best results. One can therefore expect the results obtained with a lens-system to parallel its optical limitations. Since the results obtained with the amplifying lenses depend upon the other two lens-elements, the author has devoted some space to the fully corrected series of substage condensers and objectives and, for comparison, to the "standard" or partly corrected type.

Visual Equipment

Many photographers are limited by equipment originally purchased for visual microscopic work. An Abbe condenser is employed. The objectives are achromatic, and the oculars either negative (Huygenian type) or positive (Ramsden type). Expense is often the controlling factor in determining the equipment used.

The practice of removing the ocular for use as a glass in order to study the section is possible only with a positive ocular which produces an enlarged image. The negative ocular has the same effect as that obtained by looking through the distal end of a telescope since it produces a reduced image. In this way, one may determine the type of ocular in use. One should not confuse the terms negative and positive as used above with the term positive as applied to oculars composed of positive elements. Both Huygenian and Ramsden type oculars are made up of positive elements.

Such equipment is more or less satisfactory for occasional photomicrography, although it may leave much to be desired in the way

Received for publication July 13, 1946. Department of Pathology, Wayne County General Hospital & Infirmary, Eloise, Mich.

of color correction. The curvature of field inherent in all objectives is pronounced. However, by using only the central area of the microscopic field and excluding the peripheral portion of the image which is out of focus, better results are obtainable. Hyperplane, Periplan, or Photo-ocular eyepieces will give a slightly flatter image, and they are of some advantage to the photographer. These eyepieces are made by Bausch & Lomb Optical Company, Ernst Leitz Inc., and Carl Zeiss Inc., respectively, and are designated for photographic use. They are to be used only in conjunction with the achromatic objectives. Each ocular may give a flatter field with objectives of the same manufacturer than with those of another.

Color of the Image

In order to make clear the value of standard equipment for photographic use, a few remarks on color images may be pertinent at this point.

Color aberration in the final image is due to the inability of the lens-system to focus all colors in one plane. When one color is in sharp focus, the focal points of the other colors lie outside of that plane. As a result, definition is not critical, although the microscope is focused as well as the eye can see. The use of filters or screens will decrease the color aberration by rendering the image monochromatic or nearly so, so that the image will come into more or less critical focus in one plane.[1] This does not mean that the image will be equally sharp at all points out to the edges, but that different colors at any one point may be brought into sharper focus simultaneously. Definition over the entire field is therefore improved. For example, the most commonly used tissue stain is hematoxylin and eosin. Hematoxylin is deep blue and has a spectral absorption of 560 to 600 mu. Eosin is yellowish-red and its spectral absorption is 490 to 530 mu. The combined range, therefore, is 490 to 600 mu. The combination of Wratten screens B and G, which is the photographically correct green color for this stain, has a transmission band of 510 to 600 mu.[2] By bringing the dominant wave length of the blue stain (approximately 580 mu) and that of the red stain (approximately 510 mu) to a common dominant of 545 mu, a monochromatic image of the two colors is obtained, and hence both may be focussed in the same plane. Screens should always be used with achromatic objectives for better definition and reduction of spherical aberration. Selective screens are necessary to control photographic contrast with *any* objective.

[1] Sadler, A.: Some Aspects of Photomicrography. J. Biol. Photo. Assn., 12:170, (June) 1940.

[2] Photomicrography, An Introduction to Photography with the Microscope, 13th Edition, 1935, pp. 54, 61. Eastman Kodak Co., Rochester, N. Y.

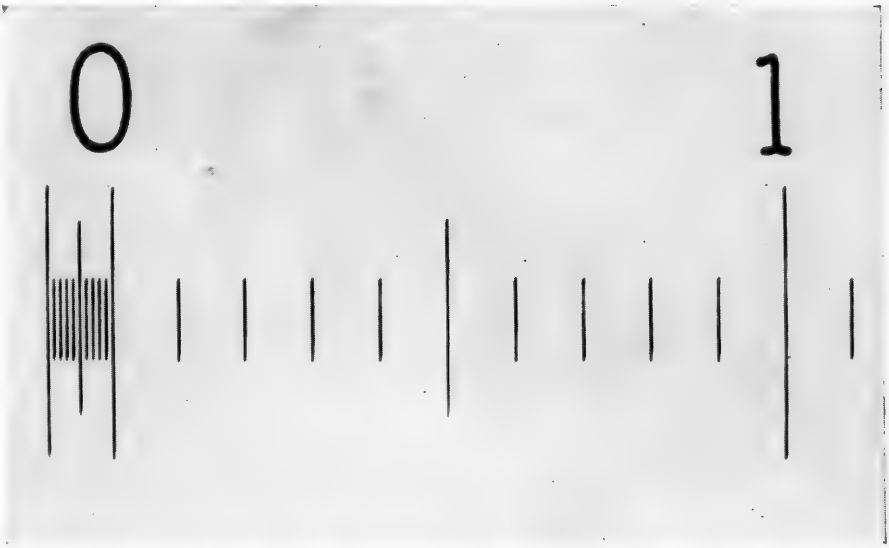


Figure 1. Homall II and 16mm apochromat. Extension 23 inches. X100. Compare with figure 2.

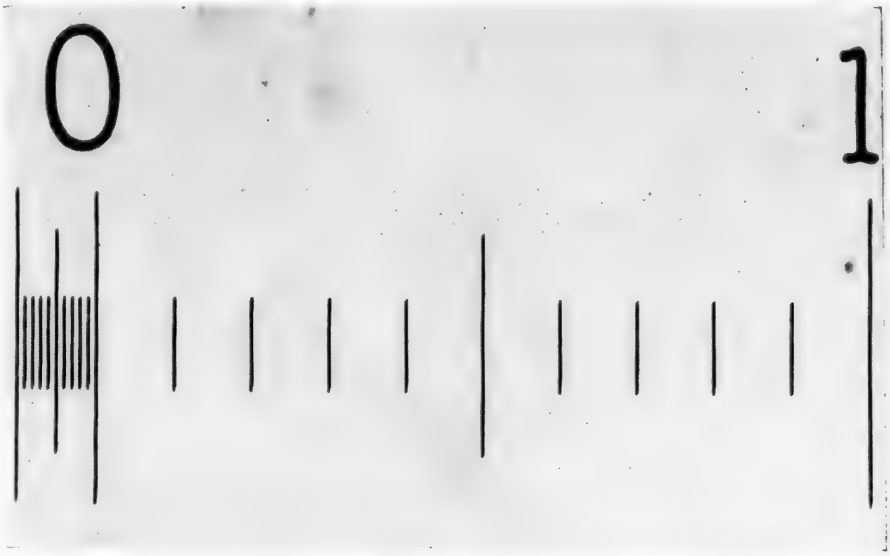


Figure 2. Compensating ocular 10X and 16mm apochromat. Extension 11½ inches. X115.

NOTE. All figures are of the same micrometer scale photographed on 5x7 Eastman Commercial (Ortho) Plates. A green screen (Wratten filters B and G) was used. The entire microscopic field was photographed, and the negative masked only to print a rectangle whose corners were superimposed on the circumference of the circular negative image. Uniform critical focusing was effected by means of a magnifying glass.

CONDENSERS

Abbé condensers are usually employed with visual equipment of standard type. They are comparable to the achromatic objectives in their color correction and should only be used with them. They are not intended for photomicrography, but, like the achromatic objectives, may be used with a green screen. The achromatic condenser is corrected for chromatic and spherical aberration and is comparable to the apochromatic objective with which it should be used, although it will improve the performance of the achromatic objective. The term "achromatic" is misleading, since it does not mean the same thing when applied to condensers and objectives. However, this is the current terminology and one must learn to differentiate between the two meanings. The so-called achromatic condenser is usually achromatic-aplanatic. It is the finest available and should be used for the best results. Just as a poor filter will spoil the performance of an expensive camera lens, a chromatically uncorrected substage condenser will prevent the corrected apochromat-ocular combination from producing the critical definition of which it is capable.

Numerical aperture (N A)[3] is extremely important in photomicrography; upon it depends the resolution of the image. The NA of the substage condenser, which should be equal to the NA of the highest objective, is usually 1.40, and is obtainable only when immersion oil is applied between the condenser, slide, and the objective. Without oil, the NA of the condenser is approximately 1.00. For dry objectives of 8mm or more, the NA of the condenser must be reduced because the field diameter of the cone of light transmitted by the substage condenser is less than the diameter of the object field when the condenser and the objective are in focus. The most simple and effective method of fully illuminating the object field is to increase the focal length of the condenser by removing its top element. The NA of approximately 0.66 is obtained with the top element removed.[4] It may vary slightly above or below this figure, depending on the manufacturer's series. In practice, the full NA of the objective cannot be realized unless it is equalled by the effective NA of the condenser. The effective NA of the optical system can never exceed the lowest NA of the lenses in use.

[3] The numerical aperture is to the microscope objective and substage condenser what the f. number is to the camera lens: a measurement of light-gathering power.

[4] The substage condenser with top element removed (effective NA 0.66) may be used with the 4mm objective (NA 0.95). The *effective* NA of the objective is 0.66 and when the image magnification does not exceed one thousand times this figure the definition obtained is critical; however, the back lens of the objective cannot be fully illuminated and a considerable increase in exposure is necessary. When the image magnification is more than 660 the full resolving power of the objective cannot be realized unless the top element of the condenser is replaced.

OBJECTIVES

The disadvantages of achromatic objectives are color aberration and spherical aberration which are quite pronounced towards the periphery of the field. These aberrations, in addition to the curvature of field, result in images which are out of focus. With these objectives, only two primary colors may be brought to a common focus. There is a difference in magnification of colors because of separation of the focal points. The spherical aberration is marked except in the yellow-green region of the spectrum.

The best objectives that have so far been made are the apochromats, in which the corrections for chromatic and spherical aberration are far superior to those of the achromats. Are these objectives essential to the best photomicrography? The standard of definition required for this work is much more exact than that required for visual use,

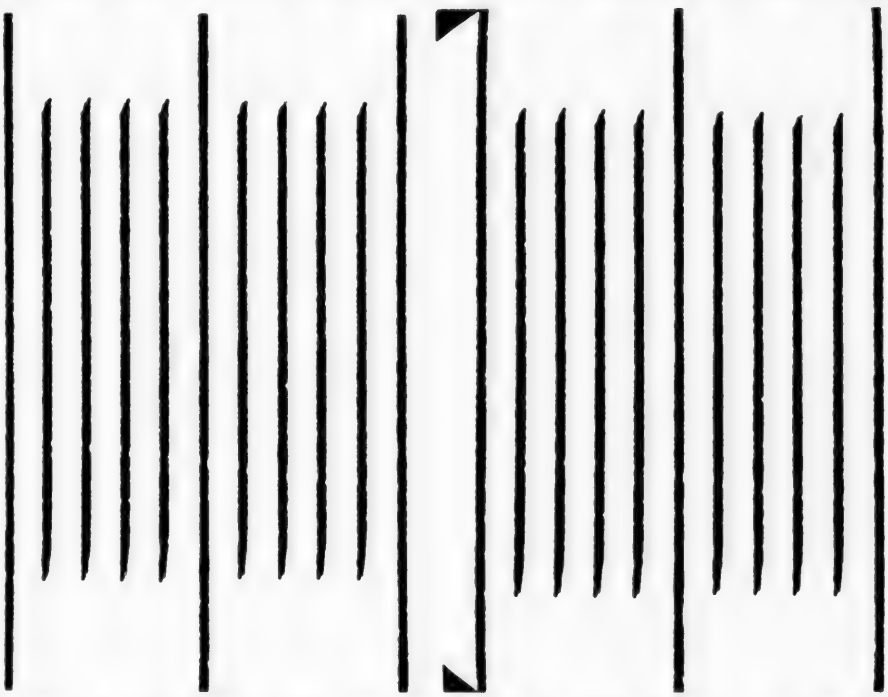


Figure 3. Compensating ocular 10× and 4mm apochromat. Extension 16½ inches. ×740.

Figure 4. Homal III and 4 mm apochromat. Extension 11 inches. ×740. Compare with figure 3.

since all focal points of the image must lie in the same plane in order to secure a photograph that is critically sharp. Because of their relative freedom from aberrations, apochromats will produce such a critically sharp image and should therefore be considered essential for the best

photomicrography. Apochromats are superior to achromats because three primary colors instead of two are brought to a common focus, and because a higher NA is obtained at given focal lengths. Spherical aberration is fully corrected. Since there is some residual chromatic under-correction, a compensating ocular must be used. Such an ocular has the necessary degree of chromatic over-correction to neutralize the under-correction of the objective..

Contrary to some opinions, the apochromat does not produce an over-all sharp, flat field. As a matter of fact, the image formed by the objective alone has greater curvature of field than that formed by the achromat. Bryson [5] gives a splendid illustration of this in a recent article, and Shillaber [6] illustrates it by means of a micrometer scale photographed with an 8mm achromatic and an 8mm apochromatic objective without an ocular. The use of the correct ocular for each objective is essential for the best possible results. The chromatic aberration of the apochromat is negligible, and with a compensating ocular the definition of the image is critically sharp. Were it not for the curvature of field, the image formed by the apochromat and compensating ocular would be sharp to the edges; whereas the image formed by the achromat and standard ocular would still be out of focus at the periphery.

The advantages of the apochromatic objectives compared with achromats are: (a) higher NA at given focal lengths, (b) correction for spherical aberration, and (c) correction for all color aberration (in conjunction with the compensating ocular or amplifying lens). The use of color screens will improve definition also, because in spite of the high correction of these lenses, there is no such thing as a perfect lens. An achromatic-aplanatic condenser *must* be used to obtain these advantages. Most photomicrography is done at magnifications of from 100 to 1500; and it is at the higher powers, particularly with the 4mm, 3mm, and 2mm objectives, that the advantage of the apochromat becomes apparent. The higher NA makes possible better resolution of fine detail; this is quite evident under the oil immersion objective.

Curvature of Field

Most workers are dissatisfied with low power photomicrographs, for the periphery is out of focus because of the curvature of field. For instance, at a magnification of 75, the image is just large enough to fill a four and one-half inch circle on a 5 x 7 negative, and since a circle four inches in diameter is printed, the entire field has to be

[5] Bryson, V.: Curvature of Field in Photomicrography. Jour. Biol. Photo. Assn. 13:182 (June) 1945.

[6] Shillaber, C. P.: Photomicrography, Theory and Practice. p. 221, fig. 101. John Wiley & Sons, Inc., New York, N. Y., 1944.

photographed. With some equipment, the periphery is out of focus to the extent of about 50 per cent of the area of the field. The magnification must be adjusted to meet the requirements of the subject, and it is not always possible to eliminate part of the field because it is poorly defined. If the magnification required will permit elimination of the margin that is out of focus, the full microscopic field is usually allowed to exceed by 50 per cent the negative area from which a print is to be made. At a magnification of 110 the image is six inches in diameter, and the diameter of the critically sharp area is four inches. The field or radiant diaphragm is stopped down until its image nearly cuts the field to be photographed. The diaphragm image, therefore, lies just beyond the circle on the ground glass which represents the printing area, thus eliminating the margin which is out of focus and at the same time illuminating only the area to be photographed. The latter is very important if the best possible definition is to be obtained, since "light-scatter" is prevented.

Figure 5. Compensation ocular 15× and 2mm apochromat. Extension 20 inches. ×2700.

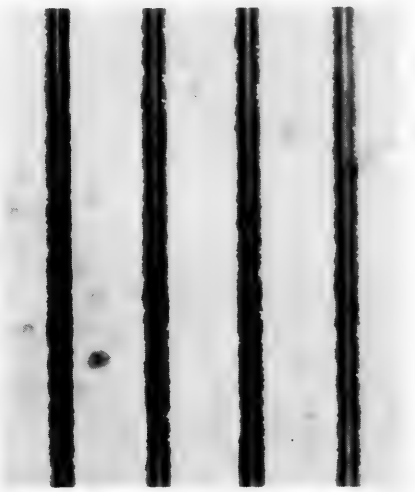


Figure 6. Homal IV and 2 mm apochromat. Extension 23 inches. ×2600. Compare with figure 5.

With achromatic objectives and standard oculars, or with apochromatic objectives and compensating oculars, the curvature of field persists, causing the peripheral area to be out of focus. With amplifying lenses and apochromatic objectives one can obtain a field which is in sharp focus from the center to the edges. A series of photographs in the literature [7] show the results obtained with various combinations of objectives and oculars. Only the combinations of amplifying lens and apochromat, and photo-ocular and achromat produce an over-

all sharp, flat field. Tests carried out by the author show that the low power field obtained with the amplifying lens is not perfectly flat, for there is a marked deflection at the extreme periphery, figure 1. However, the image is flatter than that produced by the compensating ocular, figure 2. It is possible that the peripheral distortion produced by the amplifying lens at low powers may be due to spherical aberration. The image produced by the high-dry objective and compensating ocular, figure 3, is equal in flatness and definition to that produced by the same objective and Homal III, figure 4.

Amplifying Lenses

A series of amplifying lenses designed for use with the apochromatic series of objectives are available in this country. They are manufactured by the Bausch & Lomb Optical Co. (Ampliplans), and Carl Zeiss, Inc. (Homals). These lenses cannot be called oculars, because no image can be seen through them when the eye is applied to the microscope. They are of negative focal length; the Ramsden disc or eyepoint is some distance *below* the lower element, instead of just above the top element as is the case with eyepieces for visual use. Ampliplans and Homals are designed for photomicrography, but they may be used for micro-projection at short distances. According to the manufacturers, their design allows for, and corrects the curvature of field of the objective and its chromatic under-correction.. The result is a sharp, flat image over the entire field. Amplifying lenses may be used with achromatic objectives if a green screen is employed and will give superior results compared to standard oculars.

The observer sees only one point at a time through the microscope, and he may use the fine adjustment to compensate for the curvature of field by focusing sharply as his eye travels towards the margin; therefore he is conscious only of a sharp image. A photograph of the image results in a print that is sharp in the center and increasingly out of focus towards the margins, or one in which the periphery is sharp and the central area blurred. It is necessary to have a photograph that is sharp over-all. A suitable combination of objective and ocular with filters and with adjustments of the optical system to stop down beyond the peripheral area will serve as a compromise and the results will be acceptable. If an amplifying lens is used, the entire field is flat; therefore the focus is sharp at all points.

At higher magnifications, curvature of field is progressively more pronounced and one amplifying lens will not correct all objectives. A compensating ocular with a power of 10 may be used with objectives from 16 mm to 2 mm, but a series of three amplifying lenses

[7]Ibid. p. 293, fig. 121.

is needed to cover this range of focal lengths.. Lenses are designed for use as shown in tables 1 and 2.

Table 1.

SHOWING COMBINATIONS OF BAUSCH & LOMB AMPLIPLANS AND APOCHROMATIC OBJECTIVES [8]

Ampliplan	*Power*	*Focal Length*	*Objective*
Low	5	minus 51 mm	16 mm
Medium	5.5	minus 47 mm	8 mm
High	6	minus 42 mm	4 mm, 3 mm, 2 mm

Table 2.

SHOWING COMBINATIONS OF ZEISS HOMALS AND APOCHROMATIC OBJECTIVES [9]

Homal	*Field of View*	*Focal Length*	*Objective*
I	not given	minus 20 mm	8 mm, 16 mm
II	15 mm	minus 70 mm	8 mm, 16 mm
III	9 mm	minus 20 mm	4 mm
IV	8 mm	minus 20 mm	3 mm, 2 mm
VI	13 mm	minus 40 mm	8 mm, 16 mm

Homal I is no longer manufactured and has been replaced by Homal VI. The latter will give a higher magnification than Homal II at equal extensions because its field of view is smaller and its focal length shorter. For this reason, it may be preferable to Homal II since less extension will be required. According to available reports, Homal I is a very good lens and should be used.

ADAPTERS FOR AMPLIFYING LENSES

Amplifying lenses require special adapters for standard microscope barrels. The draw-tube assembly must be removed and the adapter inserted. The tube length is reduced from 160 mm to 137 mm for Homals, and to 143.5 mm for Ampliplans. The adapters manufactured by Carl Zeiss and by Bausch & Lomb Optical Company alter the tube length to the distances just mentioned. In addition, there is an intermediate adapter which may be inserted in the Homal or Ampliplan adapter to allow an ocular to be used for visual inspection of the field. If all inspection is done directly on the ground glass, the use of the intermediate adapter is unnecessary.

Because of the wide diameter of amplifying lenses, care must be taken to exclude effectively extrinsic light at the junction of the camera and microscope and, at the same time, to prevent physical contact between them. The lens adapter has a sleeve which should fit inside the camera sleeve; but if the equipment has not been designed in this man-

[8] Bausch & Lomb Optical Co., Catalogue E 21, 1944. Rochester, N. Y.
[9] Carl Zeiss/Jena. Catalog Mikro., 390. 1934, (Th. V. Xi. 34).

ner, a black cloth may be used. The statement that photomicrography should be done in a darkened room stands reiteration.

Magnification

The computation of magnification with oculars is simple and rapid: the primary magnification of the objective times the power of the ocular, times the extension of the bellows (inches), divided by ten. A more complicated formula is

$$\frac{\text{Tube length (mm)} \times \text{power of ocular} \times \text{bellows extension (inches)}}{\text{focal length of objective (mm)} \times 10}$$

The computation of magnification with Ampliplans is made fairly simple by the use of their magnification factors, but with Homals the computation is complicated and tedious..

The Ampliplans are marked with magnifications of 5 (low), 5.5 (medium), and 6 (high), presumably at a bellows extension of 10 inches and a draw tube length of 143.5 mm. By mathematics we arrive at image magnifications given in Table 3. Different series of objectives may vary slightly in initial magnification.

Table 3.

Showing Magnifications Obtained with Ampliplans and Apochromatic Objectives

				Camera Extension				
Objective	*Power*	*Ampliplan*		10 in.	15 in.	20 in.	25 in.	30 in.
16 mm	10	low	5	50	75	100	125	150
8 mm	20	medium	5.5	110	165	220	265	330
4 mm	45	high	6	270	405	540	675	810
3 mm	61	high	6	365	550	730	915	1100
2 mm	90	high	6	450	810	1080	1350	1620

The writer is not in possession of a set of Ampliplans and therefore cannot add any working notes on the lens combinations and measurements of magnifications. The rest of this section on magnification is devoted to Homals II, III, and IV. He does not wish to imply that the lenses and equipment made by Zeiss are superior to those made by Bausch & Lomb. Generally speaking, the remarks on Homals would apply especially well to Ampliplans. Homals are not marked with any magnification factor because it varies with bellows extenssion, but by using the recommended lens combinations, the author found the image of a stage micrometer to be magnified as shown in table 4.

Table 4

SHOWING THE MAGNIFICATIONS OBTAINED WITH HOMALS AND APOCHROMATIC OBJECTIVES

			Camera Extension	
Objective	*Power*	*Homal*	10 in.	20 in.
16 mm	10	II	55	90
4 mm	45	III	690	1260
2 mm	90	IV	1300	2350

Dividing the magnification by the power of the objective and averaging the results obtained at the two extensions, the powers are roughly as follows: II, 5; III, 15; IV, 14.5. These factors will serve as a rough guide in computing magnifications. The reducing effect on the component magnification at increasing camera extension is due to the design of the lens itself and in the case of Homal II to the changing tube length as well. The required adjustment of Homal II depends on the bellows draw; the greater the draw, the further is the lens pushed into the barrel, and the shorter the tube length becomes. This adjustment is controlled by a scale marked on the lens housing as indicated in table 5.

Table 5.

TAKEN FROM CARL ZEISS CATALOGUE MIKRO 390 SHOWING THE SCALE OF HOMAL II

Camera extension in cm	19	26	33	40	47	54	61	68	75	82	88
Scale division	5	6	7	8	9	10	11	12	13	14	15

At 10 inches (25.4 cm) the Homal II is inserted to the mark of 6. However, the magnification is too low and the *area of the image too small for practical purposes.* An extension of 20 inches (51 cm) is necessary to obtain a magnification of 90. The scale division number multiplied by the power of the objective will give a magnification equal to the product, provided the extension is increased to correspond with the scale division number according to table 5. Although the Homal II is designed primarily for the 16 mm apochromat, it produces equally fine results with the 8 mm apochromat, and the latter objective eliminates the excessive bellows draw necessary with the 16 mm lens. This is quite an advantage where the draw is limited to twenty inches. Homal VI may be used with both objectives in place of Homal II. Homals III and IV require no draw-tube adjustments.

Since the field of view is known, table 2, another method of computing magnification is available. With the specimen in focus, the *full field* diameter is measured in millimeters. This figure divided by the field of view figure and multiplied by the power of the objective,

gives the magnification of the image. Actual measurements of field diameters show that this method is approximately accurate. A slight difference between the computed and the measured magnification is due to manufacturing tolerance, which in most cases ranges up to five per cent. The author found a difference of 20 per cent with Homal II, (measured magnification, 55; computed magnification, 66). The deduction is that the stated field of view (15 mm) is incorrect, and should be 18 mm.

A third method of finding magnification figures is the use of the stage micrometer. Although this method is absolutely accurate, it is time consuming when applied to each specimen and interferes with the work when there is a large volume to be done. However, one should never be without a stage micrometer since occasionally one may have to produce an exact magnification. As a working guide and time-saver, lists of magnifications shown in tables 6 to 8 have been compiled by the use of the stage micrometer:

Table 6.

SHOWING THE RANGE OF MAGNIFICATIONS WITH HOMAL II

Apochromat	*NA*	*Primary Magnification*	*Camera Extension*	*Total Magnification*
16 mm	0.30	10	10 in	55*
16 mm	0.30	10	15 in	70
16 mm	0.30	10	20 in**	90
16 mm	0.30	10	25 in	105
16 mm	0.30	10	30 in	130
16 mm	0.30	10	35 in	155
8 mm***	0.65	20	10 in	105*
8 mm	0.65	20	15 in	135
8 mm	0.65	20	20 in**	170
8 mm	0.65	20	25 in	200
8 mm	0.65	20	30 in	240
8 mm	0.65	20	35 in	280

*The diameter of this image is only 4 inches, which is too small for a 5x7 inch negative.

** This is nearly the maximum extension of the Bausch & Lomb optical bench type R, and most workers limit camera extension to this figure when using oculars. However, the Homal II is designed for extensions up to 88 mm, approximately 35 inches and definition is excellent at this distance.

***The Homal II is computed especially for apochromat 16 mm NA 0.30, but its design allows it to be used with the 8 mm objective NA 0.65. There is some curvature of field at the periphery. The 8 mm objective combination is therefore included as practical working data to bridge the gap between 155 in this table and 270 in table 7.

Table 7.

SHOWING THE RANGE OF MAGNIFICATIONS WITH HOMAL III

Apochromat	*NA*	*Primary Magnification*	*Camera Extension*	*Total Magnification*
8 mm*	0.65	20	10 in	270
8 mm	0.65	20	15 in	390
8 mm	0.65	20	20 in	500
4 mm	0.95**	45	10 in	690
4 mm	0.95	45	15 in	970
4 mm	0.95	45	20 in	1260***

*Although the 8 mm objective should be used with Homal II, the definition with III is excellent, and there is little perceptible curvature of field, so this combination is included in order to fill in between 280 in table 6 and 690 above. According to Zeiss, combinations other than those specified may be used at the expense of a slight residual curvature of field which, however, is much less than that resulting from an ordinary eyepiece.

**The top element of the substage condenser must be used; otherwise the effective NA will be 0.66.

***This exceeds the NA 1000.

Table 8.

SHOWING THE RANGE OF MAGNIFICATIONS WITH HOMAL IV

Apochromat (oil)	*NA*	*Primary Magnification*	*Camera Extension*	*Total Magnification*
3 mm	1.40	61	10 in	850
3 mm	1.40	61	15 in	1200
3 mm	1.40	61	20 in	1550
2 mm	1.30	90	10 in	1300*
2 mm	1.30	90	15 in	1850
2 mm	1.30	90	20 in	2350**

*Beyond this, the magnification is in excess if the NA 1000.

**This is about as high a magnification as one usually requires; a reasonable limit would be 2600, but this is not practical.

Magnifications of one thousand times the numerical aperture of the objective are usually considered the limit in critical resolution with standard oculars and achromatic objectives. Apochromats are capable of a higher figure than this when used with a compensating ocular, and in the writer's experience, excellent results have been obtained at NA 2000, figure 5. The use of the green screen is undoubtedly a contributory factor to these results. The Homals are said to produce critical definition at two thousand times the numerical aperature of the objective. The author has not found this to be true in experimental photographs, figure 6. A figure of NA1000 would be nearer the limit of critical definition. It must be emphasized that one is dealing with the definition on the photographic plate, and not with visual standards.

The numerical apertures for the respective lenses in the Bausch & Lomb apochromatic series described in this paper are given in tables 6 to 8. The condenser used with these lenses is a Bausch & Lomb Achromatic NA 1.40 with a focal length of 9.2 mm. Its optical qualities equal those of the apochromatic objectives.

Exposure

Several tests show that the interval of exposure with Homals is about the same as the interval of exposure with compensating oculars *at equal magnification.* Homal II produces a much lower magnification than do oculars at the same extensions, and an image of useful size requires a very long bellows draw. On the other hand, Homals III and IV produce a much higher magnification than do oculars at identical camera extensions. Therefore, all exposures should be governed by magnification, not by extension. One cannot compile a universal table of exposures as one does magnifications because there are several variable factors. Experience is the best exposure meter for photomicrography.

Cost

Amplifying lenses are expensive, costing six to eight times as much as standard oculars. Compensating oculars and photo-eyepieces each cost about three to four times as much as standard oculars. Apochromatic objectives are very expensive, costing about four times as much as achromats of equal focal length. A 2 mm oil immersion apochromat NA 1.40 costs as much as a standard monocular laboratory microscope equipped with an Abbé condenser, three achromatic objectives of 16mm, 4mm, and 1.9mm (oil), triple nosepiece, two Huygenian oculars, and a case. An achromatic-aplanatic condenser costs three times as much as an Abbé condenser. A set of five apochromatic objectives, an achromatic-aplanatic condenser, and three compensating oculars or amplifying lenses cost several hundred dollars.

The writer wishes to emphasize the fact that amplifying lenses are not in general use, partly because of their relatively high cost, but also because of a lack of discussion concerning them in the literature. No doubt many potential users do not know enough about them to warrant the purchase. It would seem that if one can afford apochromats, he can afford Ampliplans or Homals. Whether the results are worth the extra expense is a matter of opinion.

Review

Apochromats are not indispensable to good photomicrography since much fine work has been done with achromatic objectives and standard

oculars. The beginner frequently assumes that the most expensive equipment is an absolute prerequisite to good work. However, there is a difference between good work and the best work, and that difference is reflected in the quality of the photographs that are produced from the same subject by one worker when using an achromatic and when using an apochromatic system of lenses. This is particularly evident with the high-dry and oil-immersion objectives.

In considering the results which may be expected from any lens-system, one must think in terms of numerical aperture and chromatic correction, for the resolution of the image is dependent upon these factors and cannot exceed the optical limitation of the combined lenses. The resolution of the image with the apochromatic objective and compensating ocular is the finest obtainable, but the curvature of field is sometimes a disadvantage. When the compensating ocular is replaced by the amplifying lens, the same degree of resolution of the image is retained and the field is flat. Therefore, apochromatic objectives and amplifying lenses are sometimes essential for the best results.

The respective optical advantages of amplifying lenses and compensating oculars balance each other. The full field produced by the former is flatter than that produced by the latter, and the definition is equal up to a certain point. However, the full field is rarely used except at low powers; and therefore curvature of field does not become a problem at intermediate and high powers.

Conclusions Regarding Amplifying Lenses

1. The definition of the image is equal to that obtained with a compensating ocular up to one thousand times the numerical aperture of the objective.

2. The computation of magnification is tedious and complicated.

3. The diameter of the image at low powers is too small to be of practical value unless the bellows of the camera are extended to an excessive degree.

4. The field is flatter than that produced by oculars.

5 A magnification of one thousand times the numerical aperture of the apochromatic objective is the limit in critical definition with amplifying lenses, whereas compensating oculars will produce critical definition at two thousand times the numerical aperture of the apochromatic aperture.

6. In the opinion of the writer, the results obtained with amplifying lenses are not worth their higher cost, and the use of compensating oculars is recommended.

Blackened Shields for Clear Lamps In Medical Photography

John J. Beiter

FOR reasons discussed below, clear lamps without reflectors are a preferred light source if the size of the specular highlights on shiny, glistening subjects is to be kept small. Their use, however, is accompanied by such annoying and injurious glare in the eyes of the photographer that some device is needed to eliminate the glare if constant use of clear lamps can be made practicable. Blackened shields have been used in our work to retain the advantages of clear lamps while they make working with such lamps as comfortable as with any other type.

The need for a light source which adequately controls highlighting in medical photography is enhanced by the recent recognition that it is not always necessary to eliminate specular highlights. Indeed, if their size and position is properly controlled they often add considerably to the clarity and appearance of the picture, just as they do in general photography. Position of highlights is, of course, easily controllable with any light source; size is dependent upon the size of the light source.

When reflectors are used over a light source, the size of the source which determines the size of specular highlights is not merely that of the lamp itself, but of the diameter of the reflector as well. In a clear bulb the size of the light source is at a minimum because only the dimensions of the filament itself, not the bulb, are important. But this advantage is lost if a reflector becomes an additional source of highlights. It is for this reason that it has been recommended that clear lamps be used without reflectors.[1]

We have used, for both black and white and color photography, clear 500 watt, P.S.-25, 3200 degrees Kelvin Mazda lamps and two types of blackened shields. Any ordinary shiny reflector may be blackened by the method described below. Recently we have devised another type of reflector, made from a No. 10 tin can to reduce further the glare which spills over from the ordinary reflector shield. Cut out one end of the can completely, figure 1; fabricate the other end to fit the lamp socket. The open end must extend at least two inches

Received for publication June 25, 1946. The Medical Photographic Department of Pathology Laboratories, M. G. Bohrod, M.D., Director, Rochester General Hospital, Rochester, N. Y.

[1] Photography of Gross Specimens; Radiol. and Clin. Photog. 18:36, (Number 2) 1942.

beyond he tip of the lamp to eliminate the spilling over. The fabricated end should have holes punched for ventilation and a shield fastened above it to prevent light from shining through the holes into the eyes of the photographer.

Figure 1.

Method of Blackening

The main problem in the production of blackened reflectors is the result of the intense heat of the lamps which will cause ordinary paints to flake off. The following method has produced blackened reflectors which have been in use several hours daily for about two years and are still in good usable condition.

1. Clean the reflector or can thoroughly; if it is shiny, sandpaper or otherwise roughen slightly for adhesion.

2. Use a matte finish bake-on black lacquer or primer (such as Arco Flat Black Baking No. 29-129; manufactured by the Arco Co., Cleveland, Ohio, or other similar paints obtainable from local supply houses or automobile paint shops.)

3. Apply by brush or spray; or the reflector may be dipped and drained.

4. Bake in a dry sterilizer. A kitchen oven may be used provided it is not greasy. Raise the temperature gradually reaching 350 F in one hour.

5. Bake for one hour more *at* 350 F.

American Standards Association Notes

The revised edition of the "American Standard Method for Determining Photographic Speed and Speed Number", Z38.2.1-1946, was published on March 5, 1946; price—forty cents. This standard now includes the methods for sheet film and plates..

If, as it is hoped, this standard is adopted by all the manufacturers of sensitive material in this country, the speed ratings of the products will be on a comparable basis. This will simplify the exposure problem.

The standard does not attempt to solve the exposure problem under all actual operating conditions. Any effective standard must specify a set of conditions which will be used by all manufacturers to determine the data required to compute the speed. Such conditions are seldom met with in practice. The biological photographer should, therefore, be aware that any speed number or index is merely an indication of the behavior of a specific emulsion under specific conditions. There are times when the conditions in practice will not differ greatly from those used by the manufacturer in determining the speed number, and there are times when the exposure latitude of the emulsion is sufficient to accommodate any great variation in exposure produced by using the published speed number in connection with the calculator or an exposure meter.

There are other times, however, when the processing conditions differ so greatly from those set forth in the standard that the negative density produced in using the published speed number could not be used to produce an acceptable print. The author's approach to this problem has been published in this journal, and the revised standard has not changed the situation in any way..

The great value of the revised standard will be that the biological photographer will at long last have an accurate means of comparison available in evaluating the suitability of any emulsion of any manufacturer to a specific exposure problem.

Louis Paul Flory, Yonkers, N.Y., BPA Representative.

Association News

Meetings

New Los Angeles Chapter of the B.P.A. 15 biological photographers met at the Los Angeles County Hospital on July 8, 1946, to elect officers and to hear Mr. C. Graham Eddy talk on the "Veterans' Administration Program for Medical Photographers". After Mr. Eddy had finished the official part of his talk, he recounted some of the experiences he and his Medical Illustration Unit had in India, while photographing there during the war for the Army Medical Museum.

The following officers were elected by the Chapter:

President: Edward Hamilton.
Vice President and Chairman of Program Committee: Lloyd Matlovsky.
Secretary: Avis Gregersen.
Treasurer: Bill Sokol.
Directors: Zane Price, Les Morgan, Bobbie Derr.

Monthly meetings will be held; and each member has been asked to bring a color transparency each month for discussion and criticism. The August program will be a stereo-projection of specimens, by Lloyd Matlovsky.

Medical Illustrators. The proposed meeting of the Association of Medical Illustrators formerly to be held in June, will now be held Sept. 23-26, in Philadelphia. For further details, write to Miss Muriel McLatchie, Massachusetts General Hospital, Boston, Mass.

Wanted: Photographs of the Gastro-Intestinal Tract

Color photographs of benign lesions, especially ulcers of the upper gastro-intestinal tract, are needed for use in display material by Buffington's Pharmaceutical Chemists, 8 Sudbury Street, Worcester, Mass. For further particulars write to Mr. R. L. Brault, of Buffington's..

Eye-Movement Camera Designed for Research on Behavior

BPA member, Dr. Henry Roger, of Sandy Hook, Conn., has devised and built a camera for studying disturbances of attention as found in normal and neurotic behavior. This camera photographs the track of the eye-movements of an individual observing a picture or object. The specifications which had to be met were developed during discussions with Hans Syz, M.D., Secretary of the Lifwynn Foundation, where the investigations on behavior are taking place. Mr. Charles Robinson collaborated in the construction of the many electrical features.

Graphic records were needed of the horizontal and vertical components of the eye-movements; the velocity and exact course of motion; and the position and duration of fixations. The various components of motion had to be recorded simultaneously; and it was required that the whole record be easy to comprehend and analyze without complicated calculations.

A camera was produced, using 35 mm film, capable of taking from 5 to 60 or more exposures on a single frame, showing positions of the eye during travel or rest. The frame-change can be set to take place automatically at one per second, or can be manually set to vary this interval. The sequence of the eye-movements and the duration of fixations is shown by the use of a rotating dial through which flashes are projected on the cornea and from there reflected into the camera. The dial, moving clock-wise, shows the changing position of its bar, which can be analyzed readily on the film. A complete turn of the dial is usually registered on a single frame.

Since a powerful light source is needed to secure sharp photographic impressions, a flash tube is used, controlled by a thyratron tube. Disturbing effects of the light flashes are obviated by the use of an ultra-violet filter between the light source and the subject.

A projection device makes it possible for several frames to be superimposed; and also for the track of the eye-movement to be superimposed on the picture which the subject may have been asked to observe during the experiment..

This brief summary was made from the description of the camera published in Science, May 17, 1946. The mechanical and electrical features will undoubtedly be written up in detail by the designers at some future time.

The One-Year Course in Medical Photography Revised by Rochester General Hospital

In the March, 1946, issue of the Journal, pp. 146-148, available courses in medical photography and are are listed. Brief mention is made of a course at the Rochester General Hospital, N.Y., under the supervision of Milton G. Bohrod, M.D., Director of Laboratories. This course has now been revised to meet the requirements for official approval of the New York State Department of Education and the Veterans' Administration. The tuition has been raised from $50 to $100 for the twelve-month period, due to the addition of several required didactic courses. Many of our members may be interested in this curriculum, so the following outline is given:

REQUIREMENTS FOR ADMISSION. A minimum of high-school graduation. One year of college is strongly urged before entrance. Experience in general photography may be substituted for the college work.

LENGTH OF COURSE. The course extends over twelve months. Two months of this period are spent in Tissue Technic.

CURRICULUM. Instruction includes assigned reading and quizzes, the latter, one hour daily; practice at first under very close supervision; participation in the actual work of the department toward the end of the course. A written examination must be passed at the end of each division. The work is divided as follows:

1. General Photographic Practice. 10 Months (5 hours weekly).

Including ordinary darkroom technic; lighting; use of meters; exposure; making of lantern slides, prints, enlargement; flash, infrared and other special technics; will vary with the previous training and experience of the student.

2. Clinical Photography. 3 Months.

Preparation and care of patients for photography. General Technic. Special problems in connection with photography of certain regions. Practical demonstrations and repeated practice.

3. Photography of Gross Specimens. 4 Months.

Including the care, preservation, and preparation of specimen for photography.

4. Photomicrography. 2 Months.

Construction, use and care of the microscope. Preparation of specimens for photomicrography; general technic of embedding, cutting and staining tissues. General Photomicrographic technic; color photomicrography; use of polarized light, dark field, etc.

5. Miscellaneous Topics. 1 Month.

Preparation of medical charts and tables; copying x-ray films; principles and practice of projection of slides and films; preparation of materials for conferences.

6. Tissue Technic. 2 Months.

CLASSROOM WORK. The following didactic courses are required:

1. Orientation, Ethics, and Professional Adjustments. Lectures by various members of the teaching staff of the hospital.
2. Anatomy and Physiology. Lectures and Laboratory 120 hours.
3. Pathology. Lectures 15 hours.
4. Medical Terminology. 15 hours.
5. General Photographic Theory. Conferences and Lecture Quiz-

zes. 6 hours weekly. This includes the physics of light as it applies to photography; photochemistry; construction, use and care of photographic equipment; and the history of photography. Much of this section may be omitted with students who have covered these subjects in college or other courses.

6. Photo-Clinic. 50 hours.

VACATIONS. Two weeks vacation are allowed. The time must be at the convenience of the department and must not conflict with classroom assignments.

ENTRANCE. Classes start January 1st and July 1st. During the period of adjustment from war conditions, students may be accepted at other times by mutual agreement.

TUITION. $100.00 for the entire course. This includes all fees such as health fees and laboratory fees, for anatomy and physiology. $20.00 is payable upon acceptance into the school and the remainder upon entrance.

OTHER EXPENSES. Board and room is not furnished by the hospital. Meals may be obtained at nominal cost in the hospital cafeteria. The cost of books is about $25.00.

Sustaining Members

Some individuals who have a deep interest in the advance of scientific photography help finance a wider range of activities for the Association by becoming Sustaining Members. The privileges of Regular and Sustaining Members are the same. Either type may be chosen each year when the dues are payable.

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Perskie, Leonard
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St. Louis 8, Mo.

Semken, Dr. George H.
16 West 85th Street
New York, N.Y.

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Magee Hospital
Pittsburgh 13, Pa.

Smith, James
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S. Pasadena, Calif.

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Pavelle Laboratories
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The JOURNAL of the Biological Photographic Association

VOLUME 15 • NUMBER 2 • DECEMBER, 1946

Leo C. Massopust EDITOR

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The JOURNAL of the Biological Photographic Association

Volume 15 • DECEMBER, 1946 • Number 2

Official Publication of the Biological Photographic Association

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Leo C. Massopust, Editor

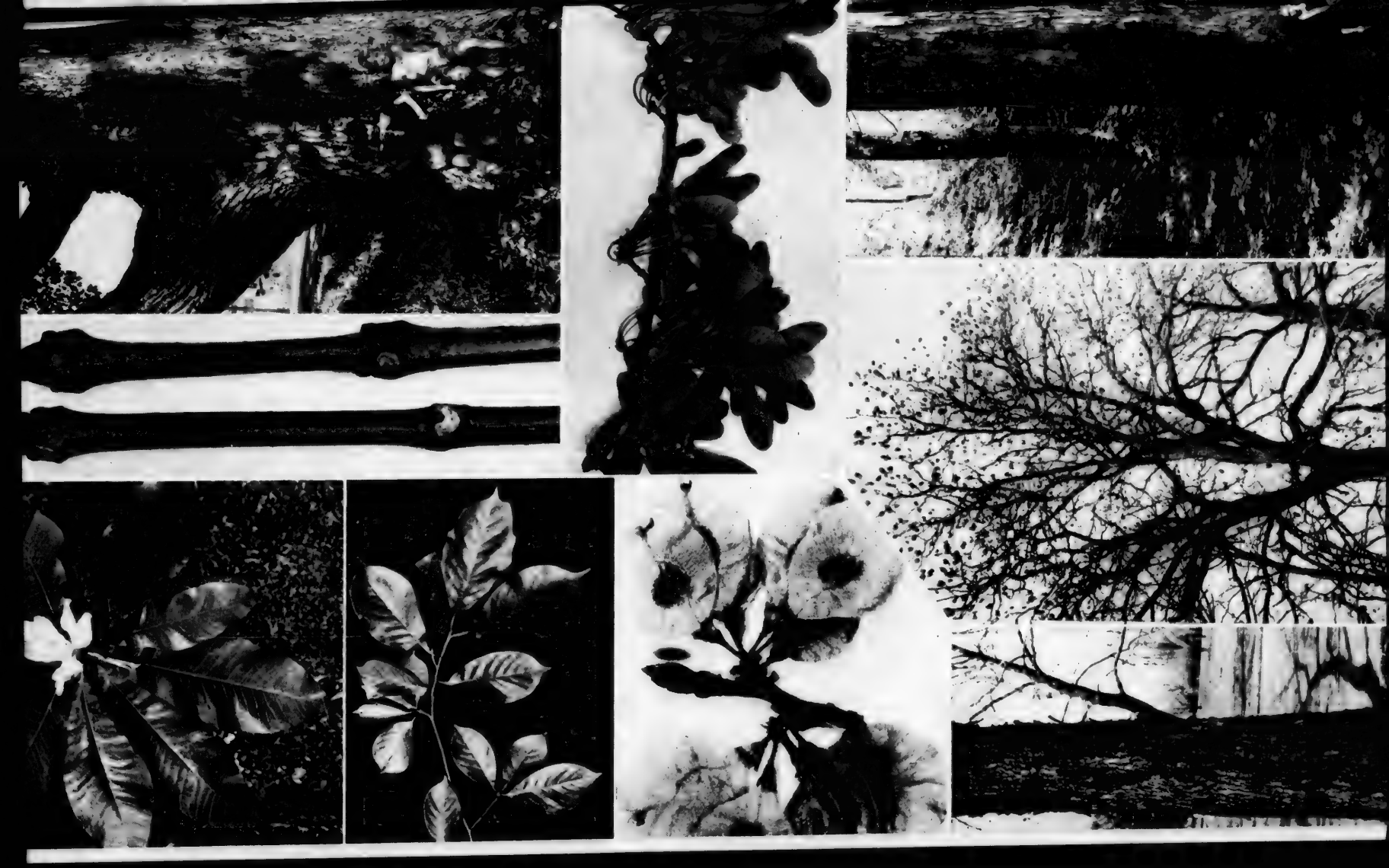
Marquette University School of Medicine

Milwaukee 3, Wisconsin

A S S O C I A T E E D I T O R S

ARTHUR W. PROETZ, M.D., Beaumont Building, St. Louis, Mo.; ANNE SHIRAS, School of Medicine, University of Pittsburgh, Pa.; FERDINAND HARDING, The Children's Hospital, Boston, Mass.; and ARTHUR W. FUCHS, 164 Inglewood Drive, Rochester, N. Y.

Published Quarterly at 561 North 15th Street, Milwaukee 3, Wisconsin. Entered at the Post Office, Milwaukee, Wisconsin, under the act of March 3, 1879. Subscription price $3.00 per volume; foreign countries $3.50. Single copies 75 cents in U. S. A.



Tree Photography As A Hobby

S. Glidden Baldwin, M.D.

WHY it is that every nature student sooner or later becomes a camera fan I don't know but I believe it is true. The two seem to go hand in hand. One soon learns to see much beauty in the outdoors that must be recorded for showing to others and keeping his own memories alive.

In nature photography, some pictures are made for study purposes, some for illustrating, others for teaching names (taxonomy) and to

Received for publication August 11, 1946. 139 N. Vermillion St., Danville, Illinois.

(Editor's Note: At the author's suggestion, footnotes 5, 6, 7, 8, 9, 10, 11, 12, constitute a bibliography, page 93.)

Legend for Opposite Page.

Umbrella Magnolia, (Magnolia tripetala). A very spectacular white flower surrounded by a rosette of large green leaves some of which may measure two feet in length. Medalist, Plus X roll film 1/50 second at f. 16.

Picture shows twigs of Red Ash, (Fraximus pennsylvanica) left, and White ash (Fraximus americana) right. Note the pubescence (hairs) on the stem of the Red ash, one of the chief distinguishing characteristics between the two species. One might also note the round leaf scar below each bud and see that the top of the scar is nearly straight across in the red, whereas it is indented in the white to receive the bud. Twigs make a very interesting photographic study. Twigs enlarged two times Plus X film pack taken with view camera 1/10 second f. 32.

Several articles, pamphlets and even several books have been published on this subject. This huge tree has a very characteristic and easily identified bark. Cottonwood (Populus deltoides). Tree found along U.S. highway 150 between Rowland and Crab Orchard, Kentucky. Tree measured 18 feet 6 inches in circumference.

Medalist, Plus X roll film 1/100 second at f. 10. The children live close by and were pictured to show size of tree.

Tupelo Leaves. Here we make use of the black background to photograph our subject (Nyssa sylvatica) sometimes called Black or Sour gum.

Medalist, Plus X roll film 1/50 second f. 10.

Slippery Elm Samaras. The seeds of the Slippery Elm (Ulmus fulva) litter the ground for a few days and then are gone, they are rather fragile and don't persist long. Picture enlarged two times natural size. Fruit is seen with wing that helps disperse it.

View camera, Plus X cut film ½ second at f. 32 with two No. 2 Photoflood lamps.

Maple Samaras. The double winged seeds of the Silver Maple (Acer saccharinum) are produced abundantly along this branch and many trees may grow from these seeds. Everyone probably knows these seeds. They are easily propagated.

Contax, Plus X roll film 1/25 second at f. 8 with two photoflood lamps.

Red Ash (Fraxinus pennsylvanica) bark. Picture taken in Forest Park, St. Louis, Mo. Medalist, Plus X roll film 1/50 second f. 16.

Beans of the Kentucky Coffee tree. Our ancestors roasted the seeds of this tree as a substitute for coffee. Picture taken near Catlin, Ill., in an old cemetery. Contax, Plus X roll film 1/50 second f. 10.

Trees grow big in the Great Smoky Mountains, Tennessee because of the abundant rainfall and long growing season, etc. Here is pictured a Yellow Buckeye (Aesculas octandra) measuring 13 feet in circumference. Bark is smooth on young trees and flakes off in large strips on older ones. Author's secretary was used to show relative size of thee. Medalist, Super XX roll film 1/2 second f. 11.

create interest, etc. The author gravitated from a nature lover, to student and then by the above route to tree photographer. I believe this love to picture our surroundings comes naturally to many of us because our ancestors since the earliest times have recorded the environment around them. Witness the famous drawings in the many caverns and grottoes of France made before historic times by the Cro-Magnon race nearly 25,000 years ago.

Today, there is a great conservation movement abroad in the land. Many societies are fostering it in its many phases: the Wilderness Society, the Wildlife Society, the National Audubon Society, the Soil Conservation Service of the Federal Department of Agriculture, Friends of the Land, The Isaac Walton League, Local County Sporting Clubs, State Departments of Conservation, The Fish and Wildlife Service of the Department of Interior and various State Universities through their agriculture schools. This movement seeks among other purposes to save our trees, our wildlife and our soil. Our very life itself is dependent on a realization that we can't continue our ruthless exploitation of natural resources, we must wake up and turn about. Photography can help—can create an awareness of the problem—and in the author's field can foster a love of trees—a wish to preserve them.

Trees make a nice subject for photography. They are fixed in position and can't get away from the camera; however, their place is sometimes difficult to get to; there may be little light (as in deep forests) and

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UPPER ROW

Left—The White (Ulmus americana) and Slippery Elms (Ulmus fulva) are our most common elms. Here their twigs are compared. The gray, hairy twigs on the left with the blunt round buds are those of the Slippery Elm. The two twigs on the right are dark brown in color, smooth, with sharply pointed conical buds and are characteristic of the American or White Elm.

Middle—Two twigs on left are Blue Ash (Fraxinus quadrangulata). Note the squareness of the twigs which easily separates this Ash from its relatives the Red and White pictured elsewhere and also gives it its specific name "quadrangulata". It is called blue because its inner bark turns blue upon maceration.

The two twigs on the right are Ohio Buckeye (Aesculus glabra). They are readily distinguished from all other tree twigs and serve as an accurate way to tell these trees apart. Twigs if studied show as many distinguishing marks as human faces and are constant for each species.

Right—Maple Twigs make interesting studies. Twig on left is that of the Box Elder (Acer negundo) or Ash-leaved maple. Note the leaf scars just below the buds go nearly around the twig.

The three twigs on the right are of the Silver maple (Acer saccharinum) so commonly used as a shade tree. The buds which are round and globular on the two right hand twigs are flower buds, the middle twig has only leaf buds. The prominent longitudinal spots are called lenticles and are breathing pores.

Except where otherwise stated, all twig pictures are enlarged two times natural size and were taken with view camera on Plus X film pack at 1/10 second f. 32 with two No. 2 photoflood lamps.

LOWER ROW

Right—On the left we have two twigs of the Red Oak (Quercus borealis var. maxima) the buds of which are shiny, glabrous, pointed.

On the right the most common oak, the White oak (Quercus alba) is represented. Here the buds are blunt and when once the two are compared and studied easily told apart. Middle—White Ash Bananas. The staminate flowers of Fraximus americana appear before the leaves and look for all the world like bananas. The pistillate flowers which produce the seeds occur on a separate tree. Thus we have male and female trees (dioecious) in others both flowers occur together on the same tree (monoecious).
Picture enlarged 2½ times natural size and taken on Plus X cut film, half second f. 32 with two No. 2 Photofloods.

Right—Oak Twigs. Here we have pictured twice natural size on the left two twigs of the Black oak (Quercus velutina)—the buds are pubescent (hairy) pointed and five angled, clustered at the tip (a characteristic of all oak twigs). The center two twigs are those of the Shingle Oak (Quercus imbricaria). The extreme right twig is from the Sycamore.

Top row from left to right.

These three sentinels stand at the edge of the Pi Beta Phi Settlement School at Gatlinburg, Tennessee, in the shadow of the Great Smoky Mountains. They have smooth, sinewy bark which like the Beech doesn't check. Their name is Hornbeam (Carpinus caroliniana). Medalist, Plus X roll film 1/50 second f. 16. Taken in February.

This bark fits like a glove—A beautiful bark. The tree is Amelanchier canadensis, Shadbush or June Berry. It bears large white flowers in the spring and berries in the summer which are edible but the birds seldom leave you a taste. The gloved hand is that of the naturalist at Pere Marquette State Park, Illinois, Mrs. Arch Nelson.

The American Elm (Ulmus americana) is probably our most popular tree, though fast following the American Chestnut to extinction because of a fungus disease.
The veteran tree pictured is yet in good health. It is located at Spencer, Indiana and measures 17 feet three inches in circumference. The author's 3½ yr. old son stands in front of the tree to show its size better. Medalist, Plus X roll film 1/25 second f. 5.6.

Second row from left to right.

One of the largest trees found in the Great Smoky Mountains in Tenneessee. A 600 year old Tulip Tree (Liriodendron tulipifera) which measures 18 feet five inches in circumference and is in very deep woods. The author is shown together with Miss Edna Banta, on left, Naturalist at McCormick's Creek State Park, Indiana, and the author's assistant Miss Mary Lou Brownsing. Medalist, Super XX roll film 1/2 second f. 16.

Sugar Maple (Acer saccharum) bark shows a certain ruggedness that reminds one of New England. This tree, however, stands in the Morton Arboretum in Northern Illinois and is a beautiful tree in fall. This species has contributed much to civilization,—shade, beauty, maple syrup and beautiful and durable maple lumber for furniture and flooring. Medalist, Plus X roll film 1/25 second f. 5.6, dull.

Blue Ash (Fraxinus quadrangulata) bark, entirely different from the other ashes and one that is easily identified.

Picture taken at Morton Arboretum, N. Ill. Contax, Super XX roll film 1/25 second f. 5.6 dull day.

Third row from left to right.

The alligator-like bark of the Tupelo (Nysso sylvatica). Tree measured 9 feet in circumference, located at McCormick's Creek State Park, Indiana. Contax, 35 mm Agfa Supreme 1/25 second f. 5.6 dull.

This tree is named from its bark. The Shagbark Hickory (Carya ovata). Bark flakes off sometimes in huge pieces. Picture taken at Turkey Run State Park, Indiana. Contax, Plus X 35 mm 1/50 second at f. 8.

White Ash (Fraxinus americana) bark, a very typical and characteristic bark. Picture taken at Morton Arboretum, Northern Illinois. Medalist, Plus X roll film, 1/50 second f.16.

The diamond pattern of the Black Walnut (Juglans nigra) sets it apart from others. This tree was photographed in the Morton Arboretum, Lisle, Illinois. Medalist, Plus X roll film, 1/50 second f. 8.

Sycamore (Platanus occidentalis) bark doesn't stretch but flakes off showing its white petticoat of inner greenish-white bark. Springtime picture taken at the Missouri Botanical Gardens (formerly called Shaw's) St. Louis, Missouri. Medalist, Plus X roll 1/100 second f. 8.

Bottom row from left to right.

The White Walnut more familiarly known as Butternut (Juglans cinerea) has a bark quite different from its relative the Black Walnut. A smaller tree, short lived and of no commercial importance, but does furnish good nuts. Tree photographed at McCormick's Creek State Park, Indiana. Medalist, Plus X roll film 1/50 second f. 6.3.

The smooth, tight fitting gray bark of the Beech (Fagus americana). This bark peculiarly enough is one of the few barks that can stretch without cracking open to form the various characteristic patterns we see pictured. This tree measured 12 feet six inches in circumference a near record for a beech and is to be found in McCormick's Creek State Park, Indiana. Contax, 35 mm Agfa supreme, 1/25 second, f.5.6 dull.

This large White Oak is the largest the author has even seen though they come larger. Tree measures 19 feet in circumference and is along Tennessee highway 71 near Norris Dam cut off road. Author placed his hat on tree to show immense size. Bark is ridged and somewhat flaky, rather light in color. Medalist, Plus X roll film 1/50 second, f.10.

they are usually crowded together. The leaves and limbs do move with the slightest breeze and their flowers are minute. The leaves, flowers, fruit, and buds do not occur all at the same time making repeated trips during the various seasons necessary. Yet, these all add spice and zest to the camera fan and give him opportunity for developing and perfecting various methods.

There is a field as large as all outdoors awaiting you if you become a nature photographer and trees will take you far afield and put you in good company. "The tree is man's best friend in nature—in his long struggle from savagery to civilization man has found the tree not only his best servant but also his best friend. From his early uses of wood for fuel, shelter, weapons and tools to his latest ones for paper and artificial silk (rayon-cellulose) man has always found it indispensable. As an ornament to his parks and gardens and as a giver of grateful shade along his hot streets and dusty roadways, man has found no substitute for trees. Poets of all ages from the Psalmist of old to Joyce Kilmer of our day, have sung its praises and will ever continue to do so. But man has wasted his heritage. The great areas of primeval forest have been so wastefully used that most of it has been cut over and is producing little or no wood, particularly wood of high quality. We have used wood of the forests, not as a crop which is gathered and then grows again by replanting, but as if it were a mine product. The Old World, long ago, learned to grow trees as the farmer grows wheat or potatoes. European states and even cities are today harvesting crops of wood sufficient for their manifold lumber needs. They employ trained foresters who sow the seed of trees, plant the seedlings, care for the growing trees and cut them down when mature." [1]

Each species of tree differs as much from its neighbor as humans do. With the camera we make these differences more apparent and more readily fixed in our mind.

When we study trees we need to record many features, for like humans they are composed of many parts and it sometimes takes careful observation of several of these features to answer the usual question "What trees is that?"

Trees Wear Coats

The bark is the outward covering or coat of the trees. Like our own coats the bark of trees differs from youth to old age and it serves very well to identify trees especially in winter when the leaves and flowers are gone.

We can change our coat when we grow older for a larger size but trees can't do this so they burst out at the seams (so to speak) and form

[1] Werthner, W. B.; Some American Trees, Introduction, The Macmillan Company, N.Y. 1935.

Top row.

Flowers of the common Norway Maple (Acer platanoides) which is used so extensively as a shade tree along our streets. The Norway is an immigrant but has become naturalized. These flowers are greenish yellow and seldom noticed but when enlarged two times appear as a bouquet from our flower garden. View camera, Plus X cut film 1/2 second at f. 32 with two No. 2 photofloods.

The First Harbinger of Spring. Even before the chirp of the spring peeper is heard or the robin red-breast is seen the flowers of the Alder (Alnus rugosa) appear as golden chains swaying in the slightest breeze. These are the male flowers and shed a beautiful rain of golden dust. Note last year's woody cone-like fruit still adhering and the stalked buds. Picture taken in February in the Great Smoky Mountains National Park, Tennessee. Contax, Plus X roll film 1/100 second f. 8.

Mountain Maple Flowers. Most maple flowers droop but here we see an erect cluster. We must go where it is cool to find the Mountain Maple (Acer spicatum) with its dainty bloom. Picture taken at 5000 feet elevation in the Great Smoky Mountains National Park. Medalist, Super XX roll film 1/25 second at f. 5.6.

Bottom row.

Mountain Camellias. In the Great Smoky Mountains in Tennessee these beautiful white flowers are called just that. The tree is Stewartia pentagyna the only tree of the tea family found native in the U.S. Medalist, Plus X roll film 1/100 second at f. 16.

Flowers of the Black Walnut (Juglans nigra) are inconspicuous and may only be announced by the hum of bees gathering pollen. In this picture note the female flower standing erect with two plumes on the newly grown twig. The round ovary will soon grow into the familiar walnut. The plumes are the split stigma of the pistil of the flower, no petals are present. Note below, hanging from the same stem but on last year's wood a catkin which is the male flower with its shower of pollen. Picture taken in "Happy Valley" a part of the Great Smoky Mountains National Park, Tennessee. Medalist, Plus X roll film, 1/100 second at f. 16.

characteristic patterns of bark which make lovely photographic subjects. These patterns are characteristic of particular species and give us our first picture needed to identify our trees.

Twigs and Buds

Twigs with their characteristic buds are also distinctive and are present all winter, making tree photography for "close-up fans" very inviting. They are very useful in identifying trees and deserve careful study. Pictured are the twigs of several species from which a novice could identify these trees in winter without leaves.

Tree Fingerprints

The leaf scars where last year's leaves dropped off of trees are as specific and different for each species of tree as human fingerprints. They are the surest way of identification known and are also present in winter when the leaves, flower and fruit are gone. Note the characteristic and different leaf scars present on all of the twigs shown.

All Trees Have Flowers

The showy flowers, particularly of our nursery advertised trees, are well known but many people do not know when the elms, the maples, the common woods trees bloom. These are inconspicuous but they may be exquisitely beautiful when enlarged. Here is an opportunity to make use of magnification in our photography and bring out their hidden beauty.

The Seeds of Trees are all Different

The author has collected the seeds of as many trees as he can and if one can beat the birds, squirrels, chipmunks and insects to them they certainly will identify any tree from which they come. Everyone knows the walnuts, hickory-nuts, pecans, etc., but how many know what the seeds or samaras of the elm look like?

Tree Shapes

Tree shapes are important in identifying some trees. "Rugged as an oak;" "Lithe as a willow;" "The spreading chestnut tree." All are quotations referring to characteristic shapes of trees. In Pin oaks the lower limbs droop. Elms are stately with vase like tops.

Leaf Shapes

Leaf shapes are the usual identifying characteristic of trees but leaves may vary a lot on the same tree, on young trees, on vigorous limbs and suckers. They are fairly specific in most cases however.

Leaves are rather easily collected and may be pressed and preserved attached to paper sheets and placed in folders and these in cabinets.

Left—Unknown Oak Seedlings. While on a trip to the "Smokies" last February some unusual acorns were found. The author found two which were sprouting and carried them home in a wet tissue and planted them in the small flower vase shown. Other acorns were saved and together with the picture of the tree were sent to the Arnold Arboretum connected with Harvard University where Dr. E. J. Palmer made an identification of Scarlet oak var. tuberculata—so named by Dr. Sargent in 1918. A rather rare variety. Contax with supplementary lens Plus X roll film 1/50 second f. 5.6.

Right—Developing pan full of Chestnut Oak seedlings. The author filled his pockets with acorns found at the lookout in Cumberland Falls State Park, Kentucky. These were planted in a developing pan not being used at the moment and they soon grew into nice seedlings. Contax, Plus X roll film 1/100 second f. 5.6.

Collections of leaves (herbariums) may be found in many museums, arboretums, Universities and Colleges and among private collectors all over the world. Many individuals and

Pictured is the pioneer tree of our grandparents. When they pushed West into Ohio, Kentucky, Illinois, they all planted Red Cedars (Juniperus virginiana) in their front yard. The tree is native throughout the region wherever limestone occurs. Picture taken at Spring Mill State Park, Indiana, Medalist, Plus X roll film 1/50 second at f. 16.

institutions exchange specimens and thus build up their own herbariums. All arboretums have excellent herbariums.

The author not only photographs trees but collects their seeds and after preserving samples for study and identification purposes he plants some. He feels more deeply interested in these trees if he can raise a tree from the seed of the tree he has recorded. He grows these trees first in pots and flats and then from cold frame to nursery and later transplants them along nature paths he is establishing at his home. The object is to eventually have all the trees native to Illinois available for study and enjoyment of anyone who would care to come and visit him.

The author has found in his study of trees that many species are not illustrated in texts and there is a need for many photographs to illustrate flowers, seeds, buds, twigs, and bark of many trees. After taking several hundred pictures of trees he still finds more and more photographic problems and he now knows why there aren't more good pictures available for such purposes.

However, it is a fascinating study and a good photographic project. These pictures will illustrate if nothing more the many problems yet faced by the amateur in tree photography.

Book Review

THE YEAR'S PHOTOGRAPHY 1946-1947. A Royal Photographic Society of Great Britain publication. Five shillings.

This interesting issue of the Photographic Journal comments on the pictorial, natural history and record photography, as shown in the recent Royal exhibition.

About twenty-five pictorial subjects, ten nature studies, and quite a number of lantern slides, sport, and industrial subjects are illustrated.

The prints reproduced represent from 10 to 12 percent of the total accepted entries. Bertram Cox, Hon. FRPS, commenting on them seems to think that they show the general trend of the work being done there, and ventures the suggestion "that maybe much of the print making may be inferior to that being done in America and sometimes elsewhere."

As an enthusiastic member of one of the international Anglo-American Portfolios, and after seeing some of the excellent results achieved by the British pictorialists, we sometimes have just the opposite opinion.

The lantern slides are reviewed by J. S. Waring, FRPS, and Oliver G. Pike, FRPS, FIBP, covers the nature photography shown in the exhibition.

American pictorialists were well represented again this year.

This issue of the Annual is a welcome and valuable addition to our contemporary photographic literature.

Ray Miess

Medical Photographic Records

Lt. Col. Carrol P. Naidorf, M.C.

IT is rather difficult to advocate an inflexible system for maintaining clinical photographic records and files; basically, any system of records which operates efficiently for the man who uses it, accomplishes its purpose. By this definition, the human mind being what it is, one would imagine that record systems would necessarily have wide variations in form and application. Actually, numerous varieties of medical photographic record systems were encountered by the author during a year and a half of interviews with medical and photographer personnel in about fifty large General Hospitals. It becomes necessary, therefore, to define a basic standard of accomplishment for medical records and file systems consistent with the basic requirements of the physician, and then to evolve as simple a system as possible to meet these requirements.

Before listing these requirements, please allow me to digress to the system by which the physician analyzes a patient. My purpose is to emphasize the importance of getting descriptive text with medical pictures. In order to make a tentative diagnosis, the doctor must have the family history, the past history and a history of the present illness. He then proceeds to his physical examination which includes inspection, palpatation, percussion and auscultation. To this is added an indeterminate number of laboratory procedures, and when these are all evaluated the doctor is pretty happy if his tentative diagnosis is right a little more than half of the time. Since in medical photography one is limited to the physical examination method of inspection only, we can see that the descriptive text which accompanies the picture must take the place of the remainder of the methods available to the doctor in diagnosis; and the medical picture, therefore, becomes of inestimably greater value when a description accompanies it. It would seem that this should be the doctor's responsibility and that he should furnish this document at some subsequent time. However, based on the unsuccessful experience of trying to locate patients' records subsequent to the taking of a picture, it has been found that the time to get the document is just prior to photography when the doctor is enthusiastic about his case and has the facts crystallized in his mind. An extemporaneous summary by the doctor at this time requires a minimum of time and effort and is of greater perma-

Received for publication September 14, 1946 from the Army Medical Illustration Service, Washington, D.C. Presented at the meeting of the Biological Photographic Association, Chicago, September 6, 1946.

nent value as an adjunct to the medical picture than a subsequent abstract of the patient's record made by a disinterested party.

Having called attention to the indispensability of a record with each medical picture, let me return to the consideration of the physician's requirements of accomplishment for a medical record system. These three requirements are:

1) Case history;

2) Case unity;

3) Case availablity.

1. *CASE HISTORY*: All physicians are especially insistent that a diagnosis, history and clinical opinion should accompany the medical photograph. This is best written just prior to, or at the time the photograph is taken, on the photography order blank.

2. *CASE UNITY*: All of any given patient's pictures and history should be contained in one folder or jacket. This is consistent with the universal medical principle of unifying all reports of laboratory tests, opinions of medical consultants, history and physical examination, surgeon's and pathologist's reports and other pertinent data, between a single set of covers. The universal system for keeping x-ray film files and records (x-rays are mentioned because they deal with photographic film and medical records) conform with this second requirement.

3. *CASE AVAILABILITY*: Medical pictures and their clinical discussions should be promptly available as *CASE UNITS*, either under the patient's name or under the medical category in which he falls.

These three requirements were studied in a consultation between the author and the Medical Records Division of the Chief Surgeon's Office in London, and a 4-unit system which meets these three requirements was worked out. The four units of this system are:

A) Day Book;

B) Patient Card Index;

C) Medical Card Index;

D) Negative File.

A) *DAY BOOK*: The Day Book is a Patient Register kept by date, starting a new page for each working day. Enter each new patient's name in the Day Book, assigning him a consecutive number before photographing. Any patient returning for progress photographs is assigned his original number and the number is encircled in the Day Book. Each negative for any one patient is given a consecutive letter of the alphabet following the number. Since the value of photographs in color

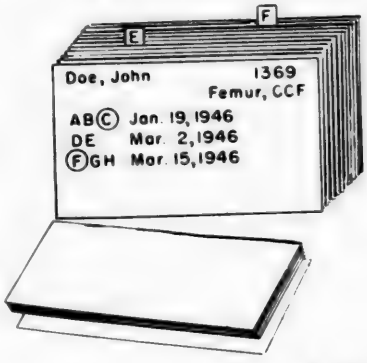
MEDICAL PHOTOGRAPHY FILE SYSTEM

A. DAY BOOK

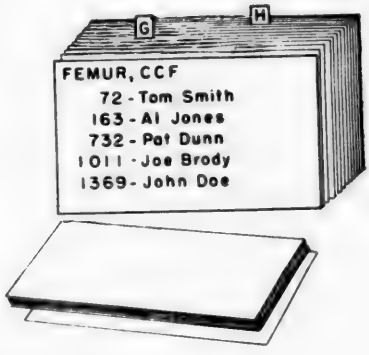
JAN. 19, 1946

NEG. No.				POSITIVES 4X5	5X7	8X10	Kod.	Lant. Slides	
1368	AB	Richard Roe	Stomach Adenocarcinoma	6		2		A	
1369	AB©	John Doe	Femur CCF	8			2		JAN. 19
137[illegible]	AB	[illegible]		[illegible]		2			
532	AB C D	John Smith							
1369	DE	John Doe	Femur CCF	6	2			D	MAR. 2
1[illegible]	C D	Al Jones							
1369	FGH	John Doe	Femur CCF	8			2	G	MAR. 15
[illegible]	AB	[illegible]							

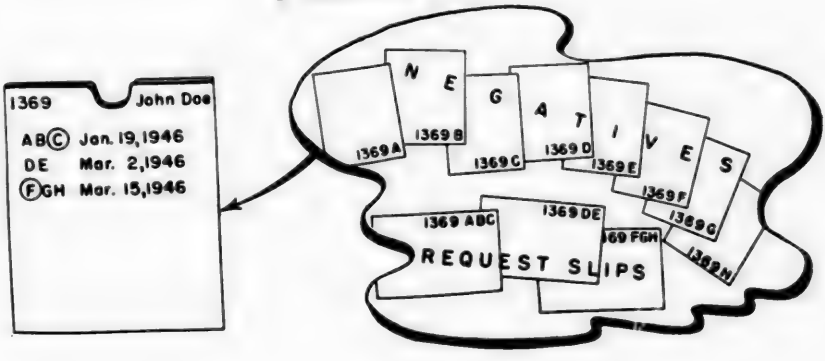
B. PATIENT CARD INDEX



C. MEDICAL CARD INDEX



D. NEGATIVE FILE



is materially greater when correlated with the rest of the case, they are given the same number as the black and white, their distinguishing letter of the alphabet is encircled; and they are kept in the same container with the black and white negatives. If a lantern slide in color is desired, a duplicate should be used for this purpose.

B) *PATIENT CARD INDEX*: This is a file of 3 x 5 inch cards kept alphabetically by patient's name. Each card contains the patient's name, diagnosis, negative number and letters, and dates photographed.

C) *MEDICAL CARD INDEX*: This file of 3 x 5 inch cards is kept alphabetically according to the medical diagnosis. Each card contains a diagnosis according to the Standard Nomenclature of Diseases issued by the American Medical Association, plus the negative numbers of patients falling in that specific category.

D) *NEGATIVE FILE*: Since each patient has only one master number, all negatives belonging to any one patient, together with his request slips containing the medical information, will automatically stay together in one container. These containers are filed by number.

The 4-unit system just described is amenable to modification to suit the individual needs of any given photographer or institution without alteration of its basic principles. For example, the Army Medical Illustration Service which received many thousands of pictures from multiple sources has found it necessary to subdivide category "D", the Negative File, into contributor groups, giving each contributor an identifying code letter. This code letter is placed in front of the contributor's negative number which is retained. The remaining three categories in this system are unchanged.

In conclusion, this is not offered as a perfect system, or as a panacea for the filing problems of the medical photographer. It is the simplest system we were able to figure out which automatically accomplishes the requirements of (1) histories and clinical summaries with negatives, (2) an automatic means of keeping the pictures and records of any one case together as a unit and (3) making case units quickly available either by diagnosis, patient's name, or patient's negative number.

Wanted

A full time medical photographer. Laboratory extremely well equipped. Photography, gross specimens, lantern slides, copying and clinical photographs included. Give previous experience and qualifications in first letter. Position permanent. THE ELLIS FISCHEL STATE CANCER HOSPITAL, COLUMBIA, MISSOURI.

An Endoscopic Color Camera for Otolaryngology and Broncho-esophagology

J. D. Brubaker* and Paul H. Holinger, M.D.†

THE camera described in this article represents an advance in the basic design of endoscopic flash cameras used to take color pictures through open-tube endoscopes. While motion pictures have been made through the bronchoscope and esophagoscope,[5] endoscopic color cameras have not heretofore been available for photography of the tracheo-bronchial tree and esophagus, using instantaneous exposures.[1] Cameras have been made which take excellent still pictures of the larynx,[5,6,7,8,9] but a radical redesign is necessary when photographing through long endoscopes. Single-frame images of color motion pictures taken through the long endoscopes are too small for satisfactory use in making color enlargements for projection, or for publication as color plates, and therefore construction of the new camera was undertaken.

Because the basic design of cameras for macrophotography[2] and endoscopic photography is very similar,[10] the new camera can be used for photographing small surface areas or shallow cavities less than 2½ inches (6.4 cm) in diameter where high intensity coaxial lighting is necessary. In addition to taking pictures through the bronchoscope and esophagoscope, with the new camera, the photographs of the larynx have been made 20 per cent larger on the film and more convenient to take than with the camera previously described.[5] Several new uses have been added—such as photography of the ear drum and mouth. Since the focusing type lens in this camera permits photography through

Received for publication Nov. 5, 1946.

* Design and Research Engineer, 805 Greenleaf St., Evanston, Illinois.

† Ass't Professor of Laryngology, Rhinology, and Otology, Univ. of Ill. College of Med., Chicago.
The camera was constructed under the auspices of the Jacques Holinger Memorial Fund.

1. Instantaneous exposures are considered in this case to be any exposure time of 1/20 second or faster. This is in contrast to some endoscopic photography through lens-system instruments where exposure times of 1/10, 1/5, ½, or 1 second are required for full exposure of type A Kodachrome film.

2. Strictly speaking, "macrophotography" implies that the film image is larger than the original object. Color transparencies when projected on a screen with the usual 2 x 2 inch still projector (with four inch focal length lens) provide a relative magnification of 2½ times for the person viewing the screen. The 2½ magnification is based upon the angle subtended by the image, at the eye, the normal viewing distance for the transparency (without the projector) being taken as 10 inches. Therefore any transparency of 0.40 life-size or higher magnification can be considered to be macrophotographic.

many types of open-tube endoscopes, the camera can be adapted for photography in the fields of proctology and gynecology by using endoscopes made for the specific purpose.

The design of this camera is based upon a compromise between the best results which may be obtained theoretically at the bronchoscopic and laryngoscopic distances.[3] Flashbulb illumination is used through the open-tube endoscopes. This produces more evenly lighted pictures than can be obtained with lens-system endoscopes illuminated by small incandescent lamps at the tip. The light from the flashbulb evenly illuminates the lumen passage to a point several inches beyond the endoscope tip. The distal light, from a small lamp or several lamps at the tip of the lens-system endoscope largely follows the inverse square law of illumination, and the light intensity rapidly falls off as the distance from the lamp increases. Pictures taken through open-tube endoscopes have true natural perspective; with lens-system endoscopes, the perspective is distorted due to the wide-angle field of view and short distance from field to lens.

Since Kodachrome film requires a very exact light value to produce proper color rendition, the flashbulb is best suited to give true color over the entire field exposed in the open-tube endoscope; this is in contrast to distal lighting where pictures are produced with the more distant parts of the field severely underexposed with poor color rendition.[11]

The importance of taking endoscopic pictures in color, rather than in black and white, can hardly be overemphasized. The black and white density values, from two different colored areas, may be identical in a black and white picture. Thus certain areas of the picture may become a meaningless gray tone, with the detail completely lost. The separation of planes in the color picture often is due to subtle shadings of color alone.

The most important features of the new camera, including certain improvements over previous cameras, are listed here with some repetition to give a better understanding of the new design:

(1) An attaching clamp at the front of the camera permits instantaneous attachment or detachment of any of several open-tube endoscopes. The clamp makes a solid mechanical connection and aligns the endoscope axis with the camera axis. A glass slide is used immediately

3. The pictures produced are slightly smaller than are theoretically possible, due to the necessity of reserving at least one stop extra light for photographing dark colored areas or open-lumen areas of the air passages where little light is reflected back toward the camera lens. It is possible to construct a camera to take a picture approximately 25 to 50 percent larger than those obtained with this camera if it is designed for photography of only one endoscopic area, where much light is reflected from the tissues, and the necessary endoscope is short. With this one exception, the camera is versatile without sacrificing the performance of any single use. That is, the ability to photograph the mouth and ear-drum was not obtained by sacrificing any effectiveness at the laryngoscopic or bronchoscopic distances.

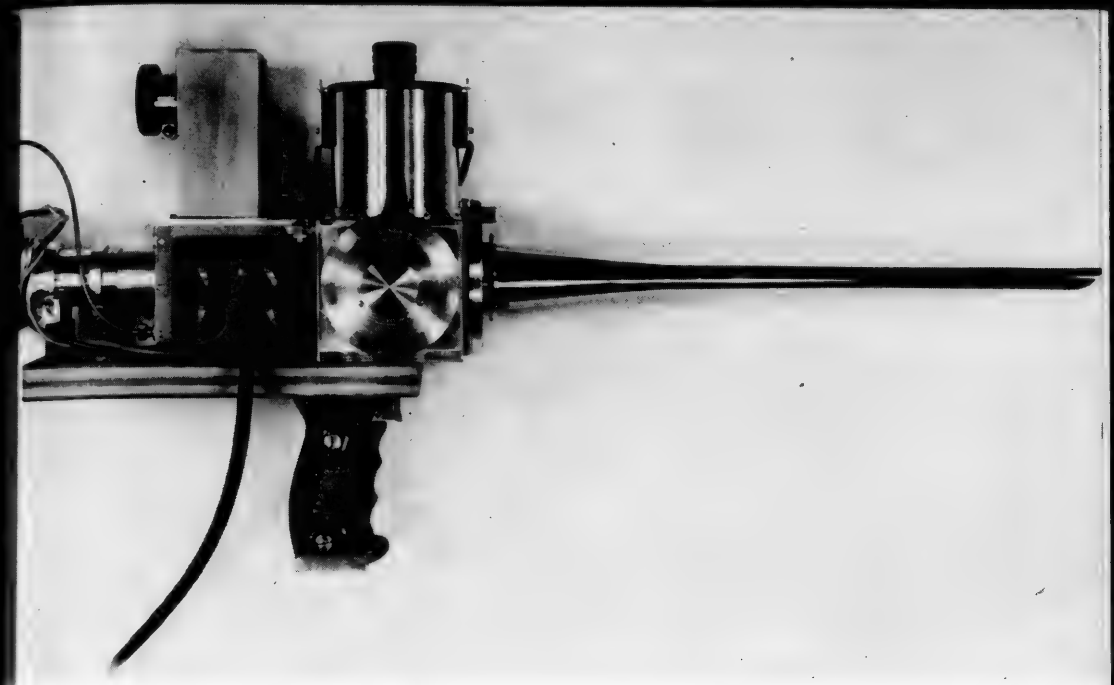


Figure 1. Right side of camera, with bronchoscope attached.

behind the attaching clamp to shield the optical parts from gross soiling or condensed moisture.

(2) A large size GE No. 50 flashbulb is used for maximum light which permits photography through relatively long endoscopes such as the bronchoscope or esophagoscope.

(3) The photographic lens is moved by a knob with rack and pinion motion to shift the plane of sharp focus to any point within several inches ahead of the endoscope tip. (In previous cameras, the plane of sharp focus was placed at a fixed distance ahead of the tip, and it was necessary to move the whole camera and endoscope to bring the object into focus.)

(4) The focusing telescope uses the camera lens as its objective lens. The telescope eyepiece shows an erect exact duplicate of the image which is recorded on the film.

(5) A removable supplementary lens provides an auxiliary distance of five inches from the attaching clamp, giving relatively large magnification (one to one) for use in photographing the ear drum or other small area.

(6) As previously mentioned, the camera was designed primarily for photography of the trachea, bronchi and esophagus, as well as for both direct and indirect pictures of the larynx. The design also permits photography of the mouth, nasopharynx, pharynx, and ear drum. By using special endoscopes, or light directing tubes, the camera can be used for proctologic and gynecologic photography.

(7) The use of a focusing type lens combined with light directing tubes (instead of endoscopes) makes it possible to use this self-contained

pre-calibrated flash camera for color photography of the oral cavity or any small surface area not over 2½ inches (6.4 cm) in diameter.

(8) The basic design of this endoscopic camera is similar in many respects to the equipment needed for macrophotography[2] and this combination of two uses for the same camera is a natural outgrowth of the similarity in optical and photographic design.

(9) Several refinements of design, notably the method of loading flashbulbs, the trigger release for the camera, and rapid semi-automatic action, provide the reliability and convenient operation so necessary when taking pictures in the relatively difficult field of endoscopic color photography where much attention must be paid to accurate finding and focusing in order to produce pictures with proper landmarks. It is more difficult to produce satisfactory still pictures than endoscopic motion pictures due to the necessity of arresting motion of the field. The convenient operation features permit more attention to be directed to the photographic problems of endoscopy.

A brief description of the camera is given in the following paragraph to show its basic arrangement. The technical aspects of each feature are then described to show the underlying theory governing the design and operation of the camera, as well as details in technic of its use.

The main aluminum alloy housing of the camera contains a 45 degree mirror, camera lens, light for focusing, flashbulb, and telescope eyepiece. A Leica camera box is attached to the rear of this housing. The camera is supported by a built-in handle which contains the trigger used to release the shutter and flashbulb. The special clamp at the front of the housing permits rapid attachment or detachment of the various special endoscopes or light reflecting tubes. Study of figures 1-8 will assist in understanding the following discussion.

Details of Construction

Endoscopes

The most obvious choice of open-tube endoscope for photography is one which is blackened on the inside to prevent stray light from fogging the picture, or to prevent reflections from the wall of the scope from being included in the picture. However, experience has shown that it is necessary to use endoscopes whose inner surfaces are brightly polished and nickel-plated if sufficient light is to be obtained on the photographic field for taking Kodachrome color pictures. Endoscopes polished on the inside will produce several times the light intensity possible with non-reflecting endoscopes. In a properly designed camera

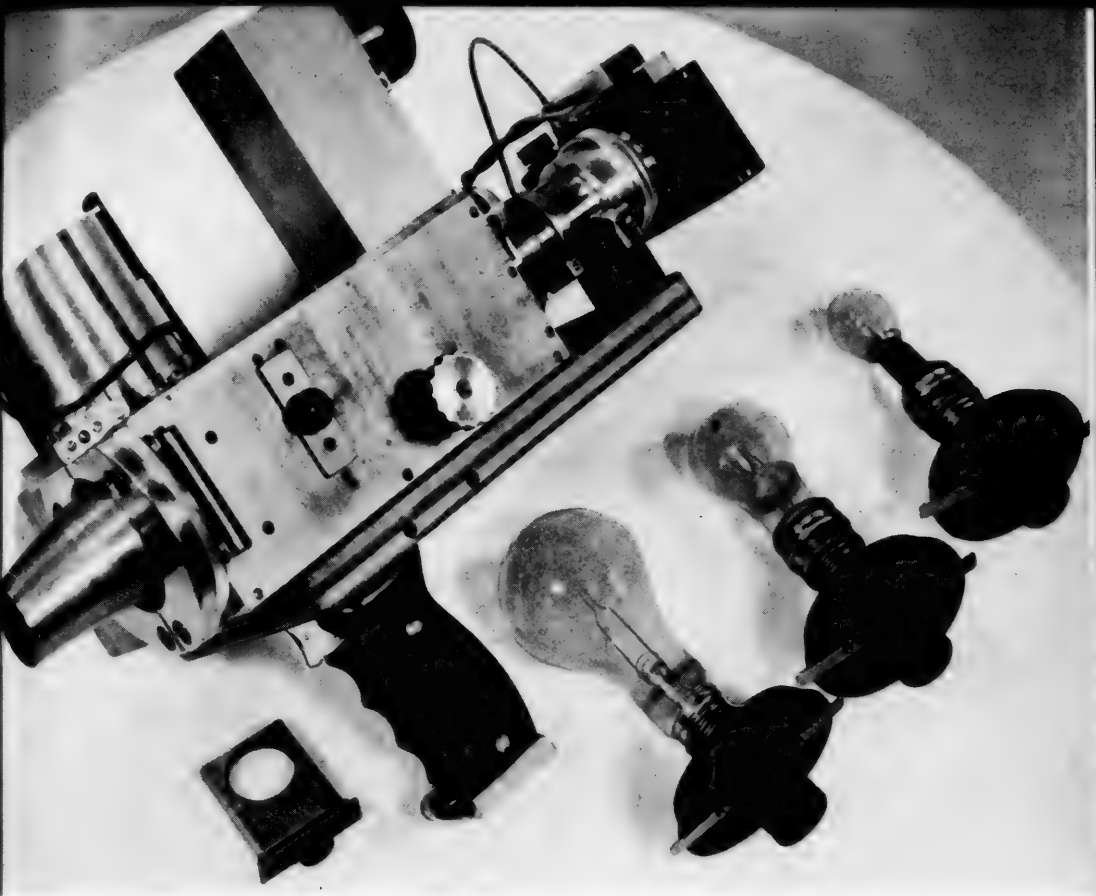


Figure 2. Left side of camera, showing glass slide, focusing knob, and supplementary lens slot. Bakelite caps are shown with two adapters for small bulbs.

and endoscope, the reflections cause no serious trouble if the finished film is masked with a circular mask to show only the circular field which is visualized through the endoscope. The inner surface of the endoscope near the tip, is threaded for a distance of one-half inch to provide a ring on the film to permit accurate placement of the mask, figure 4-a, 7, 9. The out-of-focus images reflected from the inside wall of the endoscope are covered by the mask attached to the finished film.

The bronchoscope and esophagoscope are each 16 inches (41 cm) total length. The free working distance of the scope from upper teeth is 11 inches (28 cm). Since the camera lens can be adjusted to photograph at least four inches (10 cm) beyond the endoscope tip, the total maximum effective free working distance is about 15 inches (38 cm) for the bronchoscope.

The laryngoscopes are 2½ inches shorter than the bronchoscopes, having 8¼ inches (21 cm) free working length. This length is more than is necessary for photographing the larynx, figure 5. The requirements of the bronchoscopic length determined the focusing range of the lens; this focusing range requires that the laryngoscopes be longer than normal. The camera focus can be adjusted to any point up to

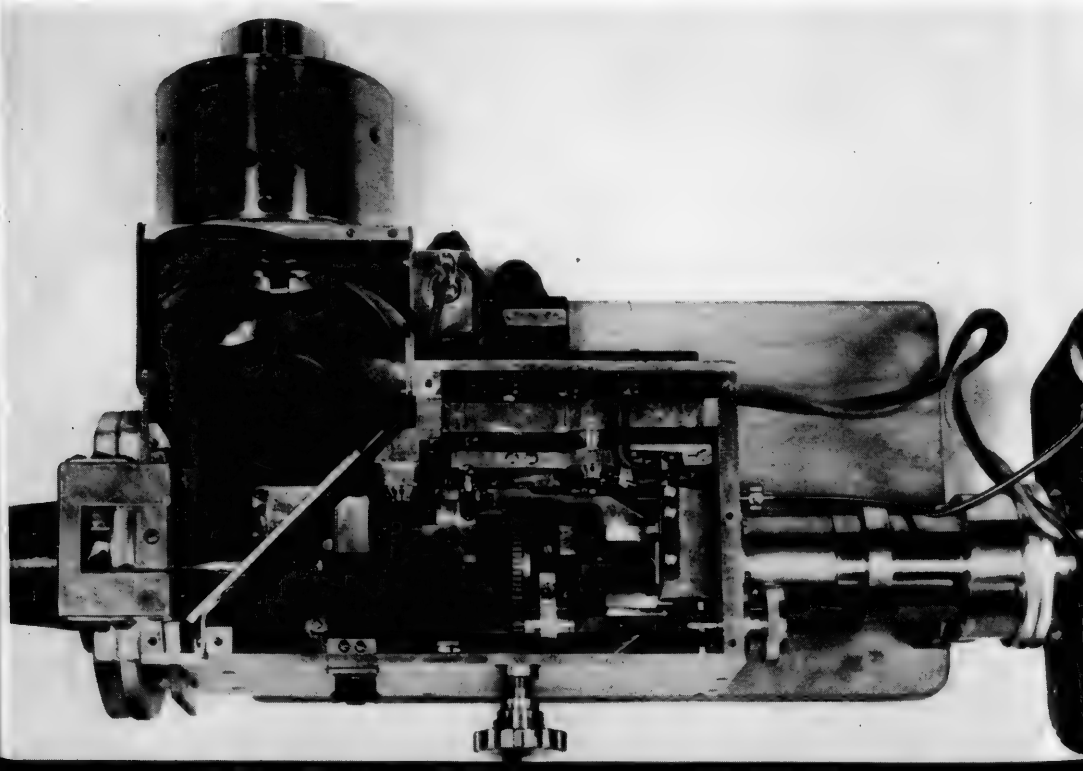
6½ inches (16.5 cm) beyond the laryngoscope tip. The shorter laryngoscope permits larger pictures on the film than can be made through a tube of bronchoscopic length, figure 6.

The bronchoscope, small laryngoscope, and esophagoscope are designed to take advantage of a larger diameter of the scope at the upper teeth, figure 4-a, 5. The slightly tapered portion shown, increases the light at the tip, compressing the light received to a smaller circle so that full illumination is had at the tip of the scope in spite of its small diameter. Each light ray entering the scope at the large end of the gradual taper is reflected several times before reaching the tip. The steep taper near the attaching flange contributes comparatively little to the total light; it is used to clear the cone of rays from the full flashbulb diameter.

The endoscopes should be heated briefly in the sterilizer just before use, so that moisture from the air passing through them will not condense on the inside bright surface. If any considerable part of the inner surface becomes covered with droplets of moisture, the light reaching the tip will be reduced, and may seriously underexpose the color film.

The endoscopes have a knurled ring, figure 4-a, immediately in front of the attaching flange, by which they can be held while they are inserted in the recess of the attaching clamp before the clamp is closed. When reattaching the camera after removing secretions from the field, the ring allows proper alignment of the scope flange, and quick attach-

Figure 3. Inside of camera housing, with top removed.



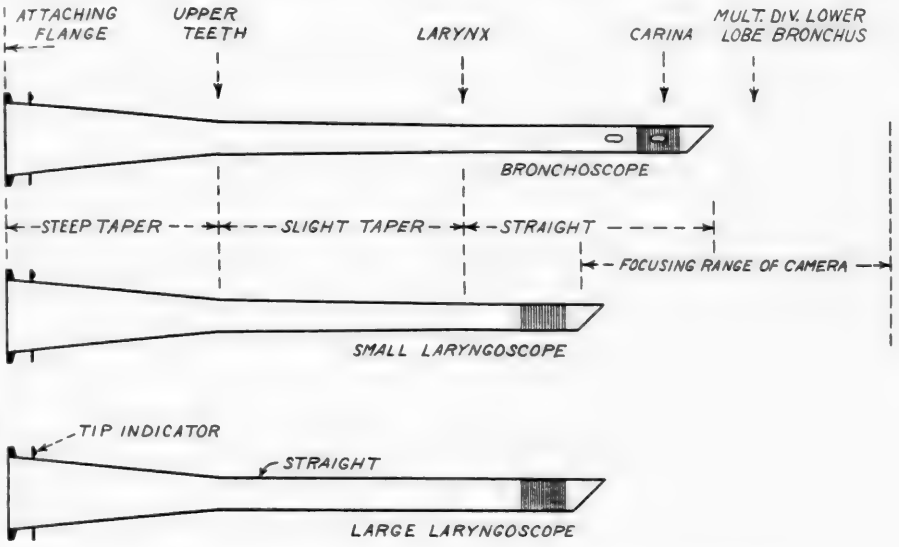


Figure 4-a. Sectional views of endoscopes (approximately to scale).

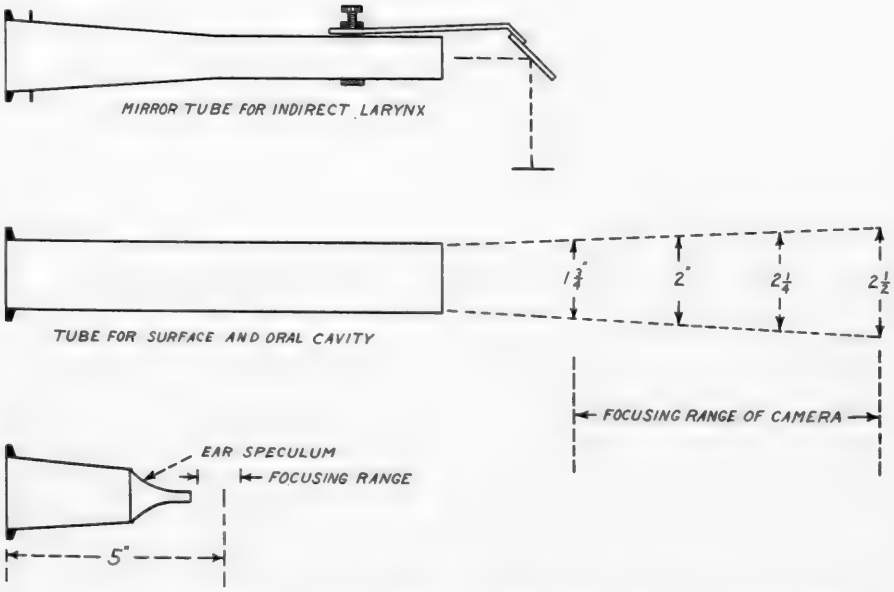


Figure 4-b. Sectional views of light reflecting tubes (approximately to scale).

ment of the camera. The tip indicator, figure 4-a, is a small raised metal knob on each scope which shows the direction of the tip. The knob can be felt by the finger, and it is not necessary to see the knob in order to locate it.

Figure 4-b shows the light reflecting tubes and ear speculum. The tube for indirect larynx pictures is similar to a large laryngoscope, except that it is shorter, and oval shaped to conform to the image of the tilted laryngeal mirror. The maximum field is thus obtained. The camera will focus closer or farther in relation to the field shown, and thus the variable mirror-to-larynx distance found in different patients causes no trouble. By inverting the mirror, the post-nasal space may be photographed; however, it is difficult to show recognizable landmarks in this region on a single field.

The tube for surface and oral cavity photography is 10 inches long and 1⅝ inch in diameter. This is a light-directing tube, used to confine and reflect the light from the flashbulb onto a surface area or into a shallow cavity. The illumination is truly coaxial, and there are no shadows produced in mouth photography, figure 10. The diagram, figure 4-b, shows the manner in which the diameter of the photographic field becomes larger at greater distances from the tip of the tube. The closest field is three inches from the tip; the farthest is 10 inches.

The light directing tube shown with the ear speculum, figure 4-b, is used to photograph the ear drum at one to one ratio (life-size) on the film. The ear speculum is 6 mm in diameter. The focusing range of the camera at the supplementary distance, figure 6, is sufficient to allow the ear speculum to be used at a fixed distance from the attaching flange, the position of the drum-membrane falling at approximately the five inch distance.

Size of Picture on the Film

Figure 5 shows the distances which govern the design of the various endoscopes for use in the air passages. Figure 6 gives the relative image size ratio on the film for each endoscopic distance. From this table it will be seen that it is advantageous to keep the field close to the endoscope tip in order to record detail in the field at the largest magnification.

Size of picture on the film is not necessarily a criterion of camera performance. The primary standard of judging results is the film image/object size ratio, figure 6. This ratio governs the proper recording of significant fine detail. Secondary to this is the total mechanical diameter of the film image which is controlled by the inside diameter of the endoscope tip. With the light directing tubes, the maximum field also

is determined by the inside tip diameter of the tubes. It will be seen from this analysis that the largest possible endoscopes should be used in order to cover a large field at the object plane of sharp focus, and give a better opportunity to show landmarks. Landmarks are more important in still pictures than in motion pictures where the field is often scanned, referring at intervals to well known landmarks.

Larynx pictures are about three-eighths inch (10 mm) in diameter on the film. Bronchoscopic pictures are about one-quarter inch (6 mm)

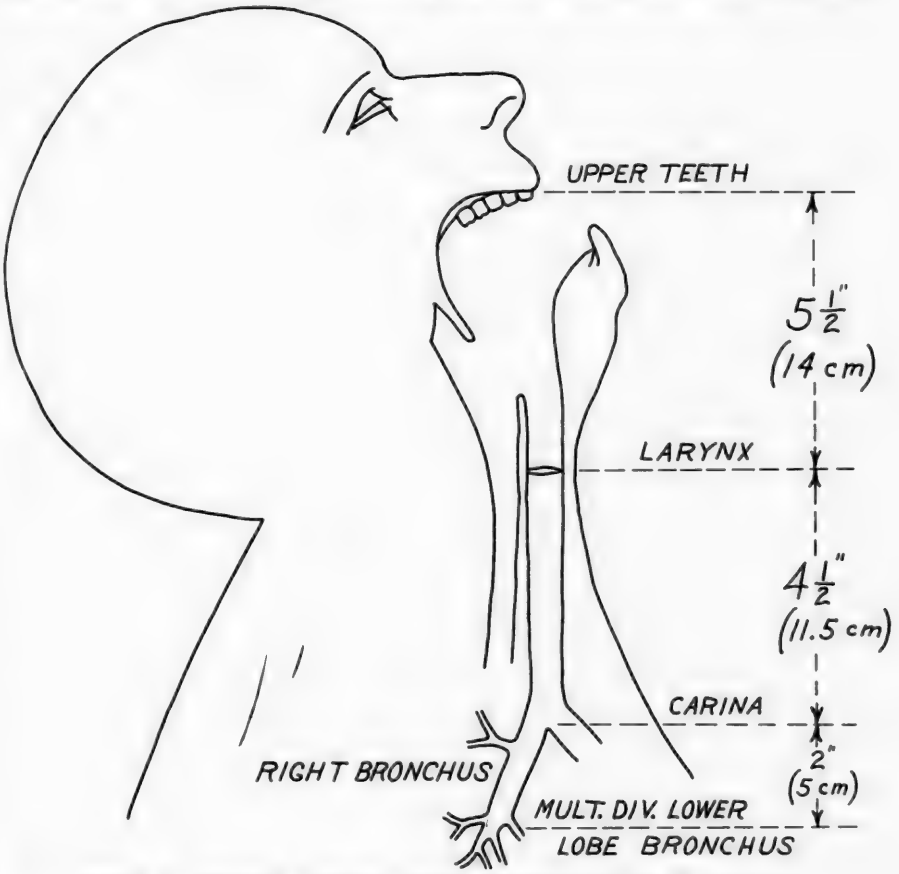


Figure 5. Distances governing design of endoscopes for air passages.

in diameter. As previously stated, the camera could be designed for slightly larger pictures, but only at a loss of margin of f. stop adjustment, and loss of depth of focus. A longer focal length lens would produce larger pictures, but would require more light. About one stop margin is necessary for photography of dark colored areas or open-lumen

views. Larger pictures (at a 10 inch endoscope distance) could be made by using a supplementary lens of about 24 inches focal length, but the focusing range of the camera is greatly reduced.

Since the bronchoscopic pictures taken with the 16 mm motion picture camera [5] are only about 0.090 inch (2.2 mm) in diameter on the film, the increase to one-quarter inch (6 mm) on the still camera represents a considerable gain in picture size. The larger diameter pictures are sharp enough to be enlarged for color plates or for color

Figure 6.

IMAGE/OBJECT RATIO and SIZE of FIELD at OBJECT

DISTANCE FROM ATTACHING-CLAMP FLANGE Inches	Image/Object ratio of magnification on the film. (Image/Object dia.)	Max possible dia. of field photographed without scope, Inches	Max Diameter of object field seen in eyepiece. Inches
19 3" Beyond tip of Bronchoscope	0.34	$2\frac{1}{2}$	$1\frac{9}{4}$
16 At tip of Bronchoscope or Esophagoscope	0.42	$2\frac{1}{4}$	$1\frac{1}{2}$
$13\frac{1}{2}$ At tip of Laryngoscope	0.56	2	$1\frac{1}{8}$
13 Minimum Distance focused upon	0.60	$1\frac{7}{8}$	$1\frac{1}{16}$
WITH SUPPLEMENTARY LENS FOR 5" DISTANCE			
$4\frac{1}{4}$	1.35	$\frac{3}{4}$	$\frac{1}{2}$
$4\frac{3}{4}$	1.06	1	$\frac{5}{8}$
5	1.00	$1\frac{1}{8}$	$\frac{5}{8}$
$5\frac{3}{8}$	0.92	$1\frac{1}{4}$	$\frac{3}{4}$

transparencies (two inches in diameter) for use in exhibits. The small pictures from 16 mm motion picture film are not satisfactory. Still pictures of the larynx and bronchi which are in perfect focus, show blood vessels as small as 0.004 inch (0.1 mm) in diameter. These are not visualized in sharp focus on the motion picture film.

The picture diameter on the film (from one-quarter to three-eighths inch) stated above might seem to be too small to record significant detail. However, if a circle of confusion on the film of 0.002 inch is taken as a criterion of excellent results, it will be seen that a diameter of a larynx picture (three-eighths inch) will be made up of at least 150 separate dot areas. If a circle of confusion of 0.004 inch is considered sharp enough for satisfactory results, there are about 75 dot areas across the diameter. Bronchoscopic pictures would have 100 and 50 dot areas respectively.

Depth of Focus

In special cases, type A Kodachrome will resolve better than 0.001 inch, but for practical results, 0.002 inch can be considered a conservative value. The narrowest line recorded on the film is about 0.002 inch (0.05 mm) wide. Many of the pictures are acceptably sharp when the film image contains no circle of confusion larger than 0.004 inch (0.1 mm). That is, an image of a point at the object is not over 0.004 inch in diameter on the film. Structures which are somewhat out of focus are acceptable for purposes of orientation of the sharp part of the field when the circle of confusion of the out of focus parts is less than about 0.010 inch (0.25 mm).

The depth of focus for sharpest possible image at the larynx is plus or minus one-eighth inch (3 mm) from the plane of sharpest focus. For a circle of confusion of 0.004 inch (0.1 mm), the depth of focus is about plus or minus one-quarter inch (6 mm). For purposes of orientation only, the depth of focus is about plus or minus three-quarters inch (20 mm), the tracheal rings and epiglottis being sharp enough at even greater distances.

At the bronchoscopic distance, the depth of focus is about 1½ times that shown above. The depth of focus for ear drum pictures at a marked lens setting of f. 18, is about plus or minus 2 mm from the plane of sharp focus; this is for a circle of confusion of 0.003 inch (0.08 mm) on the film.

Glass Slide

A heated glass slide is used immediately behind the attaching clamp, to shield the optical parts of the camera from gross soiling or condensed

moisture. The glass is optically flat and introduces no aberration into the film image. A rectangular opening at one side of the front face of the glass slide allows free passage of air through the endoscope to permit the patient to breathe freely when the bronchoscope or direct laryngoscope is used. The slide is placed at an angle of five degrees to avoid reflections.

Focusing Lamp

A 32 candle-power six volt automobile type tungsten pre-focus lamp, with parabolic mirror, projects light through the wire-filled flashbulb, onto the 45 degree mirror, and down the endoscope. The image of the lamp filament is placed at the small end of the steep cone of the endoscopes, to produce the maximum light on the field of view. A reflected light value of about 40 candles per square foot is obtained at the endoscope tip. Thus light is provided: (1) to illuminate the endoscopic area during introduction of the endoscope; (2) to permit selection of the area to be photographed; and (3) for critical focusing on the detail which is to be shown in the finished picture. It is important to have an adequate light intensity for focusing. Too low an intensity makes it extremely difficult to work rapidly and surely while finding and focusing. The light distribution from the focusing lamp is approximately the same as from the flashbulb. Reflections from the mucosal surfaces, seen in the telescope, are the same as those which will be photographed.

Flashbulb

The flashbulb, which furnishes the light for taking the picture, is a wire-filled peak type GE No. 50. The color-temperature of this bulb is about 3800 K. Type A Kodachrome requires a color-temperature of 3450 K. A type CC-15 filter is usually recommended for use with flashbulbs to correct this difference in color temperature. The difference is not serious, and the predominantly red tint of endoscopic mucosal surfaces reduces the effective color temperature somewhat by multiple reflections within the lumen, and produces satisfactory results without the filter. The catalogue rating of the No. 50 flashbulb is about 100,000 lumen-seconds total light value. The flashbulb produces an average photographic light value at the endoscope tip of approximately 1000 candles-per-square-foot reflected light for 1/25 second. The corresponding lens setting (when focused upon infinity) for type A Kodachrome (speed 12) is f.25 at 1/25 second, the duration of the flash. Since the lens is not focused at infinity, a somewhat larger opening (from f.15 to 22) is necessary for proper exposure of the film.

When taking ear-drum pictures at the five inch supplementary distance, the No. 50 flashbulb produces more light than is necessary. Consequently, smaller flashbulbs such as the Wabash press 40, or GE

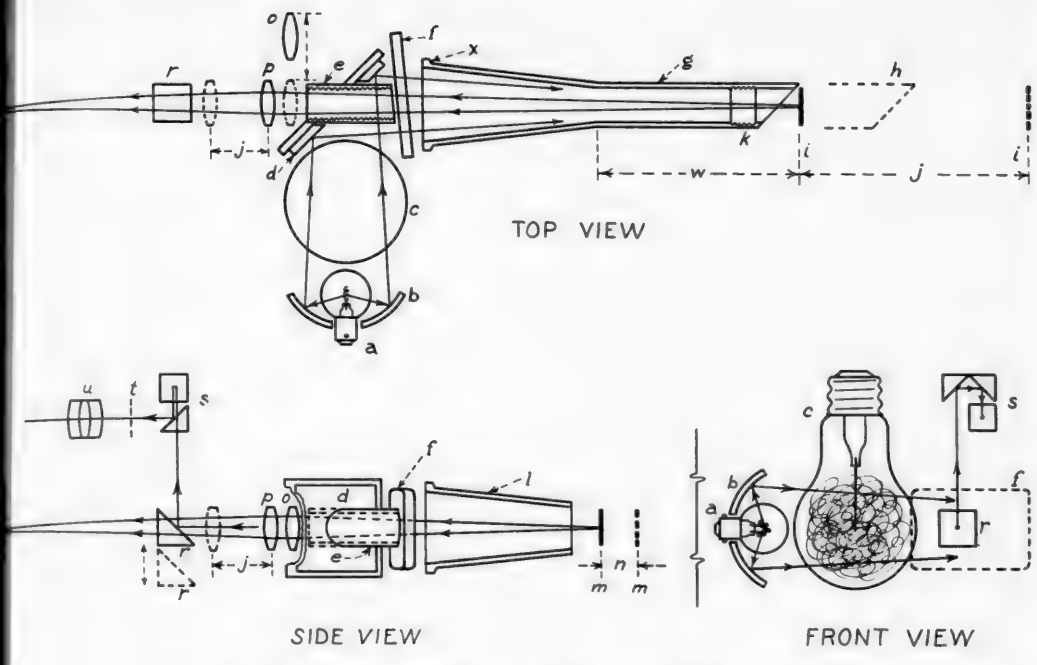


Figure 7. Optical Drawing of Camera (Diagrammatic).

a—Focusing lamp, 6 volt, 32 c.p.
b—Parabolic mirror
c—Wire-filled flashbulb
d—45 degree plane mirror
e—Tube, threaded on inside
f—Optically flat glass slide
g—Laryngoscope
h—Tip of bronchoscope or esophagoscope
i—Plane of sharp focus at object
j—Range of focus adjustment of camera lens
k—Threads to produce light ring around image on film
l—Short tube to direct light at supplementary distance
m—Object plane in sharp focus when supplementary lens "o" is used
n—Range of focus adjustment with supplementary lens
o—Achromatic supplementary lens, 28.6 cm focal length
p—Camera lens, f.6.3 tessar, 15 cm (5⅞ inch) focal length. Usable f. stops from f.9 to f.36
r—Mirror to reflect light to focusing telescope. Moves out of way when picture is being taken
s—Porro erecting system
t—Image-plane at eyepiece
u—Eyepiece lens
w—Free working length of laryngoscope
x—Attaching flange
y—Film in Leica camera box
z—Focal plane shutter in camera box

No. 22 or No. 5 can be used with an adapter extension socket to center the bulb vertically opposite the center of the 45 degree mirror.

A valuable feature is the method of flashbulb loading. The flashbulb is used in an inverted position, the base being screwed into a socket in a bakelite cap, figure 8. The cap has two insulated metal blades which engage two insulated metal plates or ears on the flashbulb housing tube. Thus a bayonet type lock is used. Three duplicate bakelite caps are used—one is in the camera, and two are kept loaded with flashbulbs ready for instant reloading. This allows reloading the flashbulb in the camera and advancing the film ready for taking the next picture in about five seconds. The used bulbs are hot immediately after firing, but can be removed from the cap by holding them by the cool glass near the base, and unscrewing the cap from them by turning the knurled knob on top of the cap. As can be seen in figure 8, the electrical con-

nection to the flashbulb is made by the two blades mentioned above, and no flexible cord to the bakelite cap is necessary.

Occasionally the flashbulb is unlocked and lifted about two inches to allow more light for focusing. This is useful if the camera is being operated at the smaller f. stops, and focusing is done at the taking f. stop. The flashbulb and cap can be replaced in the camera after focusing, in about two seconds, ready for the picture to be taken.

Camera Lens, Telescope, and Supplementary Lens

The camera portion of the equipment is somewhat similar to a reflex camera with focal plane shutter, figure 7, 8. The camera lens is a Zeiss 15 cm (5⅞ inch) focal length f.6.3 tessar in a barrel with iris diaphragm. It is mounted to permit rack and pinion focusing through a distance of two inches (5 cm) total travel. The lens stop is adjusted by an external knob on the housing; f. stops of 9, 12, 18, 25, and 36 are provided. The maximum opening that can be used is f.9. There is a slight loss in resolving power of the lens at the small stops of f.25 and f.36, due to the airy disc effect. The focusing motion permits placing the object plane of sharp focus at any distance from 13 to 20 inches beyond the attaching clamp, as seen in the telescope.

A slot in the left side of the housing is provided for insertion of a supplementary achromatic lens of 11¼ inch (28.4 cm) focal length, ahead of the photographic lens. A dummy lens-carrier is used to fill the slot while photographing in the normal 13 to 20 inch range. This supplementary distance can be used for photography of the ear drum (at one to one ratio), or for photographing a small area of skin or in the mouth, which is not over one inch (2.5 cm) in diameter, see figure 6.

Instead of a ground glass focusing screen in the camera, the reflex mirror "r" reflects the image, before photography, to the eyepiece of a telescope type focuser. The camera lens acts as the telescope objective lens. No ground glass is used at the eyepiece focal plane. Experience has shown that the mucosal surfaces of low contrast can be focused upon more accurately by using the aerial image. The eyepiece shows detail as small as 0.001 inch in diameter at the object plane. The eyepiece is 10 power, giving a relatively high magnification (5X) of the object field area. The telescope is adjusted to produce correct focus for the camera when the eye is relaxed and focused upon infinity. The eyepoint is far enough away from the eye-cap to permit the operator to wear glasses.

An important part of the telescope system is the porro erecting system which produces an erect image of the field seen at the tip of the

endoscope. It is important to have this image erect and correct from side to side, so that observing in the telescope focuser is similar to looking through the open-tube endoscope itself. If the erecting system is not used, (as is the case in most ordinary type reflex cameras) the ground glass image is erect, but transposed from side to side. This transposition is a source of potential trouble, since the effect is like reversed controls on an automobile steering wheel or airplane rudder. The endoscopist who is taking the pictures will attempt to move the endoscope tip in an opposite direction to that wanted, with consequent risk of trauma to the endoscopic passage being photographed.

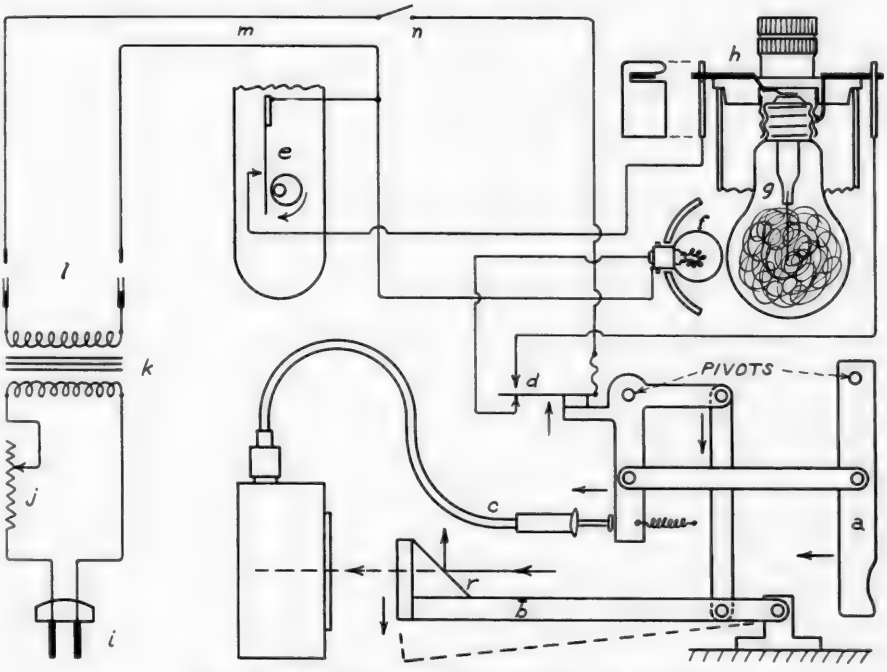


Figure 8. Electrical and Control Diagram of Camera.

a—Trigger in handle of camera
b—Lever carrying mirror "r"
c—Cable-release to Leica camera box. Focal plane shutter set at "bulb"
d—Contacts to control current to focusing lamp and flashbulb
e—Contacts on top of camera box. Cam closes contacts just as shutter opens
f—Focusing lamp. 6 volts, 32 c.p.
g—Flashbulb (wire-filled type)
h—Removable bakelite socket cap, carrying flashbulb, with bayonet connections to the electrical circuit
i—Connector plug for 115 volts a.c.
j—Rheostat for adjusting focusing lamp voltage (7½ volts)
k—40 watt transformer (10 volt secondary)
l—Connector
m—Cord 10 feet long to camera
n—Off-on switch
r—Mirror to divert light to telescope focuser

The camera field of view is narrow (see figure 6 for size of field at various distances). The telescope eyepiece field includes about two-thirds of the field diameter it is possible to photograph when no endoscope is used.

The reflex mirror, as well as the porro prisms in the telescope erecting system, consist of a front-surface aluminum coating on the hypotenuse of a right-angle prism. This is done to avoid the aberration which would be produced if the rays from the lens traversed solid glass porro prisms. Thus the full sharpness of the photographic image, just before photography, is seen in the telescope eyepiece.

Camera Film Box

The camera film box is a standard model Leica, without rangefinder or lens, which uses 18 exposure 35 mm film cartridges of type A Kodachrome film. The automatic double-exposure prevention of this camera is a valuable feature. The use of the focal plane shutter eliminates some of the mechanical problems of light-tight design of the apparatus, avoiding film fogging due to small light leaks over a long period of time.

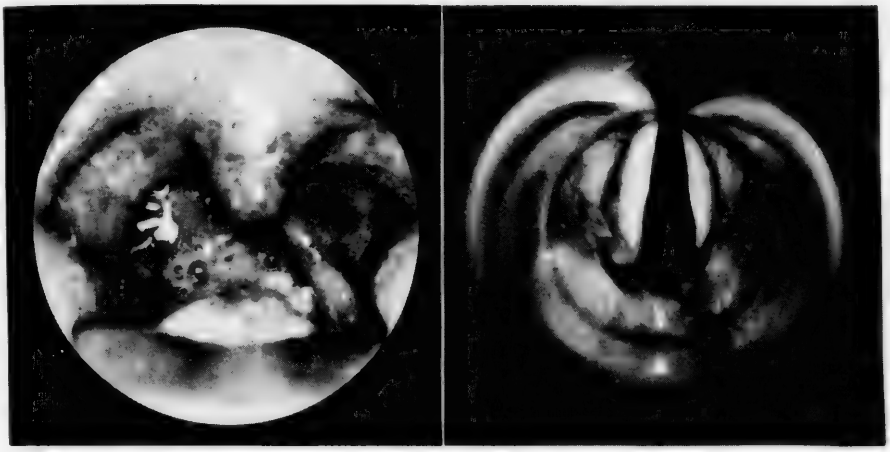
A special electrical contact box is permanently mounted in the rangefinder clip, and is operated by a cam on the shutter speed setting knob; the flashbulb is fired at the instant the camera shutter becomes fully open. The camera shutter is used on "bulb". On this setting the shutter opens when the release button is pressed, and closes when the button is released. Thus the open and shut flash method is used, utilizing all the light from the flashbulb at an equivalent shutter speed of 1/25 second.[4]

Trigger and Control Mechanism

The trigger mechanism and associated parts operate automatically and are self re-setting, figure 8. The only operations necessary to prepare for taking the next picture are (1) to replace the flashbulb, and (2) to advance the film winding knob to the next picture. This latter operation also resets the focal plane shutter. Double exposures are impossible. If for any reason the flashbulb does not fire, one frame of film is simply left blank. If the film is not advanced for the next picture, a flashbulb is wasted, since the shutter does not open and no picture is taken. Lack of the characteristic click from the operation of the focal plane shutter will show that the camera was not rewound.

4. E. Leitz has recently announced a new synchronizer (Model VIII) which has a camera base plate containing a positive synchronizing mechanism permitting the use of any standard shutter speed from 1/20 to 1/1000 second. With this base-plate (with battery operation) it would be possible theoretically, to synchronize at 1/30 second with no increase in lens opening, and at 1/40 second with only one-half stop larger opening.

The trigger lever in the handle, figure 8, is connected by levers to: (1) the telescope reflex mirror lever; (2) the switch for the focusing lamp and flashbulb circuits; and (3) the cable-release which opens the camera shutter.



Right, Figure 9. Appearance of finished film before masking, showing reflections and circle of endoscope tip.

Left, Figure 10. iew of uvula and pharynx to illustrate shadowless illumination in mouth.

A well insulated low voltage transformer provides an alternating current of five amperes at 7½ volts. This circuit lights the focusing lamp and furnishes current for firing the flashbulb. No batteries, solenoids, or magnets are used.

The focusing lamp is automatically switched off just as the trigger starts its travel. As the trigger is pulled farther, the telescope reflex mirror drops out of the light path from lens to film, and the current is connected to the flashbulb circuit ready for the contact on the film box to fire the flashbulb just as the shutter opens. At the end of trigger travel, the shutter release button is pressed by means of a built-in cable release connected to the trigger lever. The effective exposure time is the full duration of the flash—about 1/25 second. The complete trigger motion takes place within less than one-tenth second before the picture is taken. The current to the flashbulb circuit is turned off by the switch "d", figure 8, except when the trigger is pulled. This is to prevent accidentally firing a flashbulb if the bulb is replaced before the film is advanced for the next picture.

Handle

The handle has a notched filler block for three fingers, leaving the index finger free to operate the trigger camera release. The handle

is located so that the center of gravity of the camera is balanced over the hand when the camera axis is tipped forward to 25 degrees from the horizontal—the approximate angle of the endoscope when the patient is in the recumbent position for direct peroral endoscopy. A threaded hole for a tripod is located in the bottom of the handle to support the camera while taking mirror pictures of the larynx.

Technic

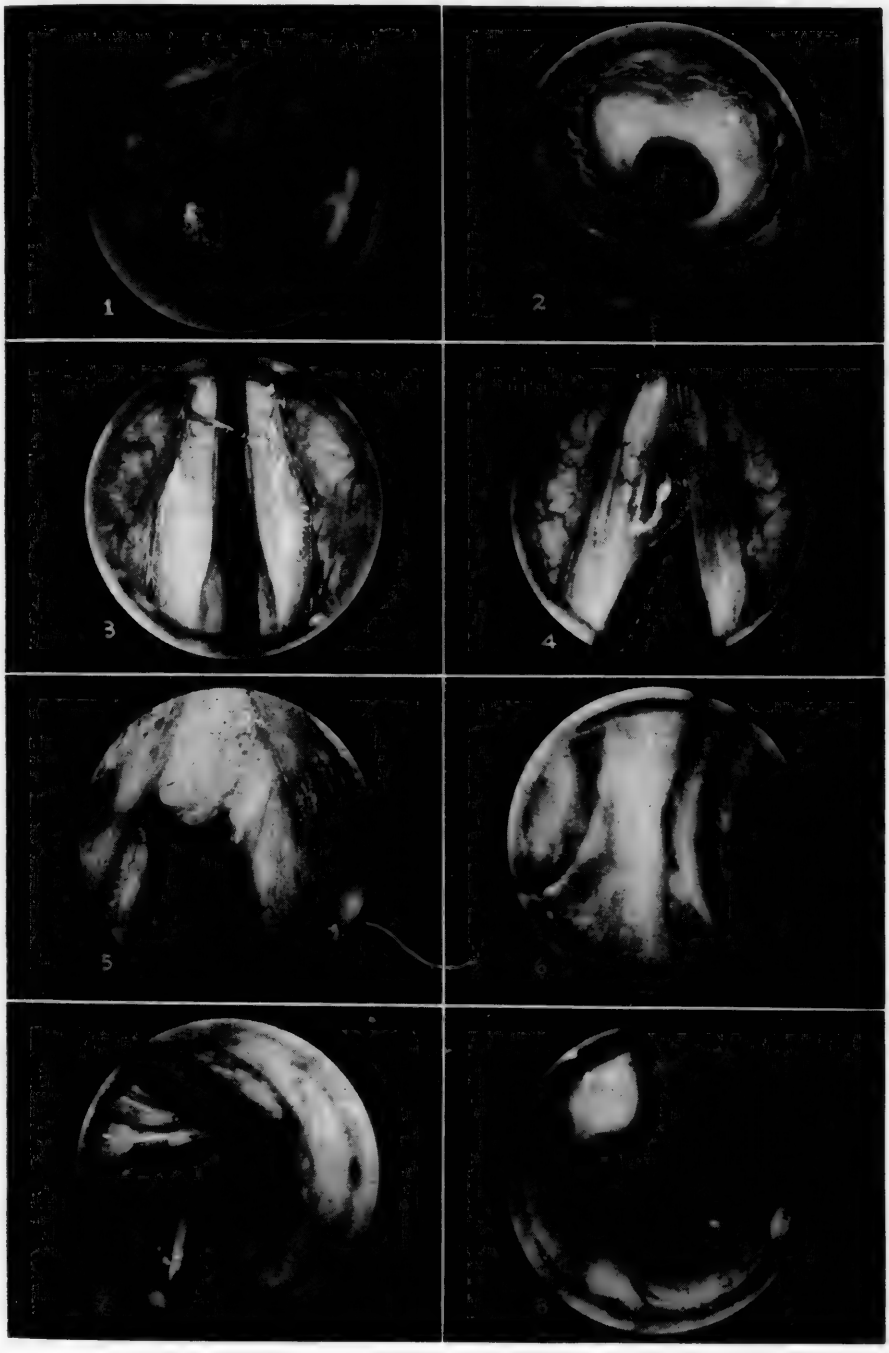
The endoscopes are heated to slightly above body temperature by an electric heating pad or by a brief immersion in the sterilizer just before use. As mentioned previously, condensed moisture on the inner surface would reduce the reflection of photographic light from the flashbulb. The glass slide for the camera is heated by an alcohol lamp, and the slide is carefully cleaned after heating so that no smudges remain. The focusing lamp is left turned on in the camera at all times, since it helps keep the glass slide warm until the camera is actually used. A spare glass slide is available should the slide in the camera become spattered if the patient coughs.

An assistant advances the film and reloads flashbulbs as required. He checks for proper operation of the camera, and records the f. stop settings for each picture for further reference, to establish standard values for photographing each endoscopic area.

The endoscopes are introduced into the patient with the camera attached, since the focusing lamp and telescope give full visualization of the field at the endoscope tip. The quick-acting attaching clamp for the endoscopes provides instantaneous release of the camera for aspiration of secretions by suction tube if necessary. In order to observe the endoscopic field when the camera is detached, a light-carrier from a standard bronchoscope of proper length is used, held inside the endoscope. Light-carrier canals and suction tubes are not built into the endoscopes since they would encroach upon the circular field and detract from the appearance of the finished picture.

Figure 11. Black and white reproductions from Kodachrome transparencies. Original film circles were ¼ to ⅜ inch in diameter. True magnifications above life-size are: (1) 4X, (2) 3X, (3) (4) (5) 2½X, (6) (7) (8) 4X.

(1) Normal ear-drum.
(2) Lye stricture of esophagus.
(3) Normal larynx through direct laryngoscope; strand of mucus across cords.
(4) Polypoid degeneration of left vocal cord.
(5) Carcinoma, anterior commissure of larynx.
(6) Normal carina (bifurcation of trachea).
(7) Right main bronchus, showing middle lobe orifice and branches of right lower lobe.
(8) Carcinoma of left upper lobe bronchus.


1
2
3
4
5

While the endoscope is being introduced, the plane of sharp focus is set just beyond the tip. Focusing for photography is done after the desired field is located. The most important part of the area is sharply focused upon by observing some small detail in it, and rapidly moving the focusing knob past the point of sharp focus several times, finally returning to the point of best focus. The depth of focus (see "Depth of Focus") in most cases is adequate to show all of the local area in very sharp detail. Areas at closer or farther distances are only slightly out of focus, and in most endoscopic areas cause no particular trouble when the finished film is viewed. Some judgment is necessary in choosing each area to be photographed, since pictures without easily recognizable landmarks have little value.

The actual taking f. stops marked on the lens vary from f.12 to f.25 for most endoscopic areas, with f.15 to f.22 about average for the larynx and tracheo-bronchial tree. The lens setting can be predicted, according to recorded values previously used on similar areas, within one-half stop. Barring gross carelessness, the exposure values are totally predictable and there is no uncertainty of results obtained with Kodachrome type A film. However, it is desirable to take several pictures of each area, since a slight change in viewpoint, not noticed at the time, often will provide a much better picture. Extra pictures also will guard against blurred pictures due to motion of the field. In either case, the best picture can be selected after the film is processed. A reduction of approximately one-half to one stop in the lens setting is made when photographing a condition in which the lumen of the passage is closed by the lesion; a smaller stop is used due to more reflected light. The larger lens opening is required if the picture consists of a view down an open lumen the same diameter as the endoscope.

Instantaneous exposures[1] are essential because many areas such as the tracheo-bronchial tree are in motion during the photographic exposure. For example, the air passages at and near the bifurcation of the trachea (carina) are in almost constant motion due to the proximity to the heart wall and aorta. The air passages also slightly change shape and position with each inspiration and expiration. The larynx is often perceptibly in motion during an exposure. In addition, there is the unavoidable slight motion of the field in relation to the endoscope tip due to handling the camera in use. This motion of the field . . . especially in photography of the larynx, trachea, and bronchi . . . requires careful judgment as to the exact instant for taking the picture to avoid excessive motion and blurring of the pictures. Vibration of the camera due to rapidly pulling the trigger release, is not a serious factor, but some care must be used. There is no problem of moving the camera

lens or film laterally in relation to the endoscope tip, since the whole apparatus from the tip of the endoscope to the film consists of a rigid structure.

Experience has shown that if a portion of the field becomes covered with blood, the pictures are not satisfactory because landmarks are immediately lost, and the red color of the blood is reflected into the other areas to distort the true color values of the adjacent tissues. Moisture condensed on the glass slide produces a pecular hazy somewhat bluish color over all of the film area, with considerable blurring and lack of contrast over all of the picture area. This can be seen in the telescope before the picture is taken.

Other Uses

Since the camera described is fundamentally a universal endoscopic type, suitable for photographing through almost any of the common open-tube endoscopes or speculums, a brief discussion of its use in proctology and gynecology is indicated.

For proctology, a sigmoidoscope of 13 inches total length may be used. This gives 7¾ inches (20 cm) free working length. A diameter of three-quarters or seven-eighths inch is suitable. An obturator is used to close the end of the scope for its introduction into the patient. The pictures obtained with this camera are smaller than those taken with a camera especially designed for the purpose.[12] (As previously stated a supplementary lens could be used for a larger picture with 10 inch long endoscopes.) The free working length of 20 cm is sufficient to photograph all types of pathology found during routine proctoscopy. For anal photography and adjacent areas, the surface photographing tube previously described can be used.

For photography of the cervix uteri, light-directing tubes about 10 inches long of various diameters are suggested, used with a vaginal speculum. The light-directing tube can be aligned externally with the speculum, and the picture focused and taken in a few seconds. A further refinement would be an alignment sleeve attached to one of the speculum blades to hold the speculum coaxial with the light-directing tube to prevent reflections from the proximal portions of the blades.

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Fellows of the Biological Photographic Association

At the Chicago convention the Directors of the BPA witnessed the culmination of their desire to give recognition to deserving members of the Association, on the basis of craftsmanship and contributions to biological photography. The first group of Fellows, numbering 34, was presented to the membership at the official luncheon on September 6. The first Fellows are members of long-standing who have labored to establish the Association on a firm basis; members who would have received this honor in past years if such a grade of membership existed earlier.

The Fellowship was not instituted without deliberation over a period of years on the part of the Directors. Now in its sixteenth year, the BPA has attained recognized stature, and it is fitting that special recognition be given those who meet the qualifications stated above.

It is gratifying to record the names of these Fellows with the year in which each joined the BPA. They have indeed earned the right to use the letters FBPA.

JULIAN ALEXANDER CARLILE, 1931, The Rockefeller Institute for Medical Research, Princeton, N.J.

RALPH CREER, 1931, The American Medical Assn., Chicago, Ill.

C. GRAHAM EDDY, 1934, Veterans Administration, Washington, D.C.

LOUIS P. FLORY, 1934, Boyce Thompson Institute for Plant Research, Inc., Yonkers, N.Y.

ARTHUR W. FUCHS, 1932, Eastman Kodak Company, Medical Division, Rochester, N.Y.

EDWARD N. HAMILTON, 1939, College of Medical Evangelists, Loma Linda, Calif.

FERDINAND R. HARDING, 1932, Children's Hospital, Boston, Mass.

JOSEPH B. HAULENBEEK, 1931, Rockefeller Institute for Medical Research, New York, N.Y.

NATHAN S. HORTON, 1936, Ayerst, McKenna & Harrison, Ltd., New York, N.Y.

LEONARD A. JULIN, 1932, Mayo Clinic, Photographic Dept., Rochester, Minn.

JEAN KIEFFER, 1931, Uncas-on-Thames State Tuberculosis San., Norwich, Conn.

ALBERT LEVIN, 1933, Montefiore Hospital and University of Pittsburgh, Pittsburgh, Pa.

ROGER P. LOVELAND, 1932, Eastman Kodak Company, Kodak Research Laboratory, Rochester, N.Y.

ADOLPH MARFAING, 1935, 530 W. 166th St., New York, N.Y.

WILLIAM L. M. MARTINSEN, 1933, 1840 North Mason Avenue, Chicago, Ill.

LEO C. MASSOPUST, 1933, Marquette University, Milwaukee, Wis.

JOHN A. MAUER, 1937, Ansco, Chicago, Ill.

STANLEY J. MCCOMB, 1936, Mayo Clinic, Rochester, Minn.

HENRY W. MORRIS, 1931, University of Minnesota, Minneapolis, Minn.

WILLIAM F. PAYNE, 1933, Roswell Memorial Institute, Buffalo, N.Y.

LEONARD L. PERSKIE, 1934, Graphic Studios, New York, N.Y.

DR. ADRIANUS PIJPER, 1939, University of Pretoria, Pretoria, Union of South Africa.

(Convention "SHOTS," opposite page, through the courtesy of Pierre Le Doux, Wood, Wis.)

Convention "Shots"

DR. ARTHUR W. PROETZ, 1935, 1010 Beaumont Bldg., St. Louis, Mo.
OSCAR W. RICHARDS, 1932, American Optical Co., Buffalo, N.Y.
HENRY ROGER, 1931, Rolab Photo-Science Lab. & Rolab Studio, Sandy Hook, Conn.
GEORGE L. ROYER, 1938, Calco Chemical Div., American Cynamid Co., Bound Brook, N.J.
FRANK N. RUSLANDER, 1937, Harper Hospital, Detroit, Mich.
ALBERT SADLER, 1938, Eloise Hospital, Eloise, Mich.
ROBERT A. SAGE, 1934, Southwestern Medical College, Dallas, Tex.
ANNE SHIRAS, 1932, University of Pittsburgh, Pittsburgh, Pa.
ARTHUR L. SMITH, 1939, Cornell University, Ithaca, N.Y.
WILLIAM J. TAYLOR, 1932, Temple University, Philadelphia, Pa.
LLOYD E. VARDEN, 1939, Pavelle Color Incorporated, New York, N.Y.
STELLA ZIMMER, 1931, Syracuse University, Syracuse, N.Y.

From the President

The conclusion of a year's activity always calls for an appraisal of progress or lack of it in the previous twelve months. May I suggest that time be taken to scan the minutes of the Business Meeting and the report on the Convention contained in the Association News, as the information contained therein indicates trends in our thinking. Of particular interest are the Treasurer's report, with its implications of the necessity for increased dues, and the report of the Editor. Yearly conventions are one means of holding us together. The Journal is an even greater cohesive force, the value of which cannot be measured in terms of cost, as so simply stated in the report of the Editor.

The first group of Fellows was presented to the members at the Convention, and the method of awarding Fellowships clarified by an amendment to the Constitution, as stated in the Association News. May I remind you that nominations for Fellowships to be awarded in the ensuing year must be in the hands of the Secretary by March 1 to be acted upon by the Board of Directors. Application blanks may be obtained from the Secretary.

To those interested in the educational and training aspects of biological photography the Lancet for August 31, 1946, carries two articles which indicate an increasing awareness of the importance of photography in medical education, and the necessity for a recognized status for the medical photographer. The articles make cheering reading.

The 1947 Convention in Rochester, New York, should be an outstanding one. A local committee is already at work on plans for the meeting. See inside of front cover for announcement.

STAN MCCOMB.

Association News

1946 Convention

Our meeting at the Hotel Bismarck in Chicago, September 6-8, was one of the best we have had. One hundred forty-two registered, which tops our previous record at New York in 1945, by 31.

The program was interesting; the members had ample time to visit the exhibits. At the official luncheon on September 6 the first group of Fellows of the Biological Photographic Association was announced by Ferdinand Harding. Further details about the announcement are given elsewhere in this Journal.

At the banquet Morris Fishbein, M.D., Editor of the Journal of the American Medical Association, gave an amusing but valuable talk on the floods of illustrations that descend on scientific editors these days. He stressed the necessity of limiting pictures to the significant few that best illustrate the author's main thesis. In his Dr. Pepys Diary, which appears in the column "Tonics and Sedatives" of the Journal of the A.M.A., the following paragraph was published September 28, 1946:

> "September 7—Some days of toil and this night to dine with the Biological Photographic Association, finding all jolly with joyous fluids and told them of the Editor's troubles with pictures for publication. Here Arthur Proetz presided brilliantly with tales of his house and his dog."

Dr. Proetz called upon the following to receive the thanks of the Association for the excellent Convention arrangements: Dr. Jay Garner, Chairman; Charles Lindsay, Mervin La Rue, Maria Ikenberg and Dorothy Pinkham. Special mention must be made of Ralph Creer's good management of the program, hotel arrangements and many other matters. There was a loud round of applause when Dr. Proetz called on "Mother McCreer."

Since the titles of most of the papers appeared in the September Journal, they will be omitted here. The proceedings of the Business Meetings follow.

Business Meeting

Hotel Bismarck, Chicago

The meeting was called to order September 6, 1946, at 11:40 a. m. by Stanley J. McComb, President. He described the difficulties under which the Salon Committee was working, in hanging last minute entries, and asked that in the future members make a point of sending in their prints well ahead of time.

Report of Progress. The report which Mr. McComb read for the year 1945 to 1946 made the following points:

The BPA had 542 members as of September 1, 1946. This number represented an increase in membership of 128 in the 14-month period from July 1, 1945, to Sept. 1, 1946. This period had been considered, rather than a 12-month period, because the beginning of the fiscal year had recently been changed from July 1st to September 1st.

The Board of Directors elected to Fellowship, upon recommendation of a Fellowship Committee, 34 members comprising the first group of Fellows of the Biological Photographic Association.

Suggestions relative to a curriculum for courses in biological photography were sent to Tom Jones in support of his plan for the foundation of an Institute for Visual Education. Also, a survey of the general field of biological photography was prepared in response to requests from personnel workers in education (vocational guidance).

It was not possible to exhibit at the A.M.A. meeting in San Francisco, due to lack of space in relation to the great number desiring to exhibit.

The construction of Salon print-stands, planned for this year, had to be postponed because of the lumber shortage.

There is a continually increasing interest in better biological illustrations and the years ahead should show constant growth in this field. Training programs embracing the whole range of biological photography are needed. Some programs are being offered. A summary of these has been published in the Journal 14: 146-148, March 1946 and 15: 50-53, September, 1946.

Report of the Nominating Committee. Mr. McComb called on C. Roland Burd, Chairman of the Nominating Committee, for his report. William Taylor and Maria Elsasser Ikenberg were the other members of this Committee. Mr. Burd read the following nominations:

President, Stanley McComb; Vice-President, Louis P. Flory; Secretary, Anne Shiras; Treasurer, Stella Zimmer; Directors, Mr. Graham Eddy, Oscar Richards, and Edmond J. Farris.

After this report and the other reports that follow, a motion was made and passed that the report be accepted.

Report of the Motion Picture Committee. Dr. Richards, Chairman, stated that Dr. H. E. Morton of the University of Pennsylvania and Chairman of the Committee on Materials for Visual Instruction, Society of American Bacteriologists, was now a member of our Motion Picture Committee. Dr. Richards said that the Committee had as usual published a list of the films made by our members, and had replied to eight requests for information about teaching-films.

Report of the Questionnaire Committee. Arthur Smith, Chairman, said the questionnaire we send out to new members has been revised so that it can all be printed on one page, and can be filled out more easily. In discussing the completed questionnaires received from members, he said the columns most heavily checked were those requesting information in various fields. In order of frequency, the following fields were checked:

1. Photomicrography. 2. Specialized Motion Picture Technic. 3. The Group Comprising Zoological, Botanical and Entomological Photography. 5. Endoscopic Photography. 6. Ophthalmic Photography. 7. High Speed Photography. 8. Color Photography as Applied to Science.

Report of Two New Chapters. Mr. Harding said that the group which had met several times in Boston this year was not a new Chapter, but an old one re-formed. The former Boston Chapter had been inactive during the war, but had held a meeting in the middle of last winter with the Boston Group of Medical Illustrators. It was found that these combined meetings of artists and photographers had worked out well, since many of the same problems were faced by both groups and each could contribute useful information to the other. He urged other Chapters to make contacts with illustrators if possible.

Edward Hamilton spoke briefly about the new Los Angeles Chapter. An effort had been made to start such a Chapter before the war, but without success. He said that Avis Gregersen's move to Los Angeles had been a loss to Chicago, but a gain to Los Angeles. Their Chapter is now about thirty members strong. It is felt that both the Association and the local members will gain by this organization.

Constitutional Amendment. The following amendment to Article IV (Election of Members), Section 2 was presented by the Board of Directors:

"Application for Fellowship by a member must be made by another member and endorsed by a third member. The member making application must bear full responsibility for the capabilities of the person sponsored, and must list the candidate's qualifications in a statement which must be signed by the sponsoring and endorsing members. Applications must reach the Secretary before March 1st for consideration by the Board of Directors in that year. Election to Fellowship shall be by a two-thirds vote of the Board of Directors. The Board shall vote on candidates annually, in meeting or by mail."

The motion that the amendment be accepted as read was carried unanimously.

Discussion about Association Dues. Mr. McComb pointed out that we had incurred a deficit for the fiscal year 1945-46. He mentioned the difficulties of publishing the Journal and running the Association on our present dues; and said Journal and other costs were certain to rise this year. Several members (Mr. Eddy, Mr. Harding, Mr. Morris, Mr. Sturgis, Mr. Tuttle, Dr. Proetz, Mr. Sadler, Mr. Fuchs) expressed the opinion that dues should be raised. None of the members present dissented. Dr. Proetz reminded the meeting that it takes at least a year to amend our constitution, and that therefore it might be wise not to specify the amount of the dues in the constitution, but instead to make provisions for a yearly recommendation about the amount of the dues by the Board of Directors.

Dues ranging from $4 to $6 for Active members were briefly discussed. Mr. Massopust suggested that we find out by a show of hands how many members favored a raise in dues. As practically all hands were raised, the vote was not counted. It was decided that a committee should study our probable costs and income, and recommend to the Board the amount of dues for our three classes of members: Active, Fellows, and Sustaining Members. The Board would then draw up a constitutional amendment to be voted on at the next business meeting.

Second Business Meeting

The meeting was called to order by Mr. McComb.

Elections. Mr. McComb asked Mr. Burd, Chairman of the Nominating Committee to re-read the nominations. Nominations were then invited from the floor. Mr. Massopust moved the nominations be closed. The motion was seconded and passed unanimously. The Secretary was instructed to cast one ballot for the entire slate.

1947 Meeting Place. Mr. Massopust spoke briefly in favor of Rochester, N.Y. Our last meeting there was in 1937. Mr. Fuchs invited the BPA to meet in Rochester in 1947. It was resolved by unanimous vote that, conditions proving favorable, the Association accept his invitation.

The meeting adjourned shortly before noon.

Respectfully submitted,

ANNE SHIRAS, *Secretary.*

First Annual Meeting, Association of Medical-Illustrators

Miss Jean Hirsch, Chairman of the Publicity Committee, has sent the following account of the meeting of the AMI:

"The Association of Medical Illustrators, organized in Chicago in July of 1945, held its first annual convention the week of September 23rd, 1946. The meetings were held in the Society Room of the Jefferson Medical College, Philadelphia, Pa.

In addition to routine business and reports of all committees, there were discussions on the training of the medical illustrator; requirements for membership in the Association; plans for a Max Broedel memorial to honor the great figure in medical illustrating; and numerous other subjects of immediate interest to the Association members.

To the great disappointment of everyone, illness made it impossible for Mr. Elon Clark, Chairman of the Board of Governors, to attend the meetings, but his place as presiding officer was excellently filled by Mr. Willard C. Shepard, who took over at the last minute and conducted the many sessions with characteristic ability and calm.

On Monday, September 23rd the Blakiston Company entertained at cocktails in their offices. Monday night the Association dinner took place at the Bellevue-Stratford. Mr. Tom Jones, President, made his address, and guest speakers were: Mrs. Max Broedel; Dr. Julio Cueva, Department of Allergy, Mexico City; Dr. Robert Dickinson, Honorary Chairman of the National Committee on Maternal Health; C. Graham Eddy, Chief of Medical Illustration Service, Veterans' Administration; Dr. Stanley Olson, Mayo Foundation, Rochester, Minn.; and Dr. Stanley Reimann, Lankanau Hospital Research Institute and Institute for Cancer Research. On Tuesday evening the W. B. Saunders Co. were hosts at dinner at the Franklin Inn Club. Mr. A. M. Greene acted as master of ceremonies, and other speakers were: Dr. I. S. Raudin, University Hospital, Philadelphia; Dr. Stacy Guild, Johns Hopkins Medical School, Baltimore; Mrs. Max Broedel. On Wednesday at the Association's luncheon at the Benjamin Franklin Hotel special addresses were made by Mr. Walter Kahoe of the J. B. Lippincott Co. and Mr. L. R. Benedict of the Phototype Engraving Co. on medical illustrations from the publisher's point of view, and on the engraving and printing of medical pictures. Wednesday evening Mr. Lea Hudson, of the Lea and Febiger Co., and Mrs. Hudson entertained at a buffet supper at their home at Valley Forge.

The meetings were attended by 43 members of the Association, coming from Canada and all parts of the United States, out of a membership list of 65. It was also attended by occasional representatives from the medical book publishers, and by two young men from Mexico, students of Mr. Jones in Chicago.

The Association of Medical Illustrators, at the conclusion of its first annual meeting, had the unanimous feeling of real accomplishment, and

of a further solidifying of the foundations upon which its plans for the future are building, plans to 'promote the study and encourage the advancement of medical illustration and allied fields of visual education; to advance medical education, and to promote understanding and cooperation with the medical and related professions'."

George Semken, M.D.

Dr. George H. Semken, surgeon, who specialized in the diagnosis and treatment of cancer, died in New York City on September 16, 1946, after 45 years of active practice in that city. Dr. Semken was among the first doctors to realize the value of photographic records. Early in his career he developed a technic for photographing his own patients and amassed a valuable collection of photographic case-histories.

He joined the BPA in 1934. In 1936 he became a Sustaining Member and continued his renewals in that group until his death. At our 1945 Convention he was guest of honor at the banquet, where he illustrated his talk with many of his own medical pictures. Members who knew him well realize that the BPA has lost a loyal and interested friend, and will learn of his death with deep regret.

B.P.A. Officers and Committee Chairmen

PRESIDENT: STANLEY J. MCCOMB, Section of Photography, Mayo Clinic, Rochester, Minnesota.

VICE PRESIDENT: LOUIS PAUL FLORY, Boyce Thompson Institute for Plant Research, Yonkers 2, N.Y.

SECRETARY: ANNE SHIRAS, University Office, Magee Hospital, Pittsburgh 13, Pa.

TREASURER: STELLA ZIMMER, Photographic Department, School of Medicine, Syracuse University, Syracuse 10, N.Y.

EDITOR OF JOURNAL: LEO MASSOPUST, Marquette University, Milwaukee 3, Wis.

MOTION PICTURE COMMITTEE: DR. OSCAR RICHARDS, American Optical Company, Scientific Instrument Div., Buffalo 11, N.Y.

PUBLIC RELATIONS COMMITTEE: DR. ARTHUR W. PROETZ, 1010 Beaumont Building, St. Louis 8, Missouri.

ANNUAL AND TRAVELING SALONS: NATHAN S. HORTON, 22 E. 40th Street, New York 16, N.Y.

QUESTIONNAIRE CHAIRMAN: ARTHUR L. SMITH, Photographic Science Service, Cornell University, Ithaca, N.Y.

Sustaining Members

Some individuals who have a deep interest in the advance of scientific photography help finance a wider range of activities for the Association by becoming Sustaining Members. The privileges of Regular and Sustaining Members are the same. Either type may be chosen each year when the dues are payable.

Baldwin, Dr. Glidden S.
139 Vermillion Street
Danville, Illinois

Bell, Dr. Dennistoun M.
"Broadview"
Amagansett, N.Y.

Brubaker, J. D.
805 Greenleaf St.
Evanston, Ill.

Cammon, W. A. "Don", D.O.S.
Cameron Surgical Specialty Co.
666 West Division Street
Chicago 10, Ill.

Creer, Ralph P.
American Medical Association
535 N. Dearborn Street
Chicago 10, Illinois

Eddy, C. Graham
Veterans Administration
Washington 25, D.C.

Esposito, Elsie
167 Bush Street
Brooklyn 31, N.Y.

Flory, Louis Paul
Boyce Thompson Institute
for Plant Research
1086 Broadway
Yonkers 2, N.Y.

Footer, Dr. A. Wilson
2828 Summit Street
Oakland 11, California

Gibson, H. Lou
Eastman Kodak Company
343 State Street
Rochester 4, N.Y.

Hill, Thomas T.
% The Edwal Laboratories, Inc.
723 Federal Street
Chicago, Illinois

H., P. H.
Chicago, Ill.

Horton, Nathan S.
Ayerst, McKenna & Harrison, Ltd.
22 E. 40th St.
New York 16, N.Y.

Jackson, Dr. Chevalier L.
255 South 17th Street
Philadelphia 3, Pa.

Lester, Henry M.
101 Park Avenue
New York 17, N.Y.

Mallory, Dr. Robert, 3rd
Alden Park Manor
Philadelphia 44, Pa.

Maurer, John
Ansco
247 E. Ontario Street
Chicago, Illinois

Miess, Ray
1800 N. Farwell Avenue
Milwaukee 2, Wis.

Perskie, Leonard
Graphic Studios
231 10th Ave.
New York, N.Y.

Proetz, Dr. Arthur W.
1010 Beaumont Bldg.
St. Louis 8, Mo.

Schmidt, Dr. Florian E.
The Armour Laboratories
1425 West 42nd Street
Chicago 9, Illinois

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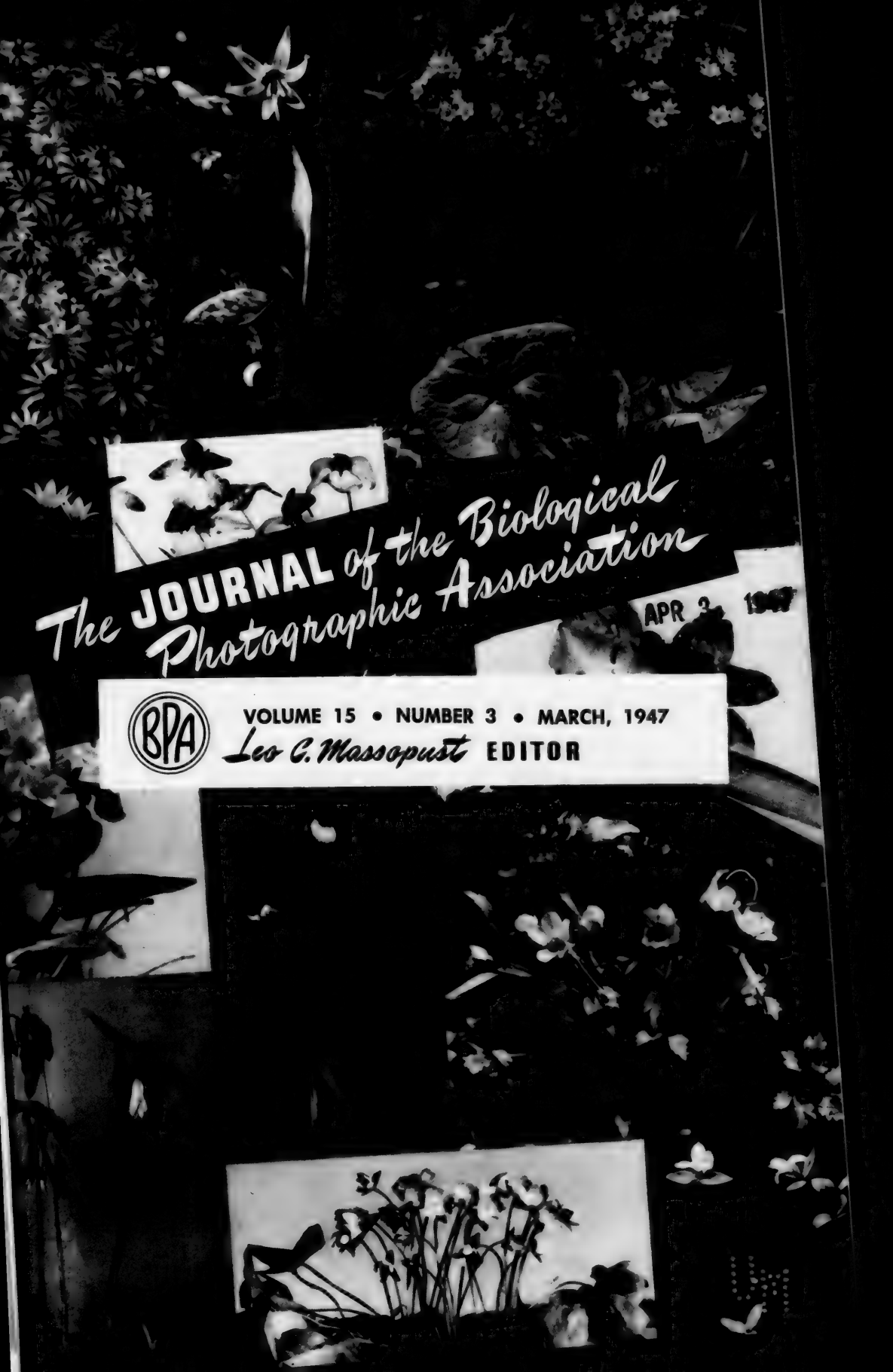

The JOURNAL of the Biological Photographic Association

APR 3 1947

VOLUME 15 • NUMBER 3 • MARCH, 1947

Leo C. Massopust EDITOR

1947 CONVENTION

Biological Photographic Association

The 1947 B.P.A. Convention Committee has made extensive plans for the meeting September 10-13, 1947. The Seneca Hotel, Rochester, New York, will be Convention Headquarters. Room reservation applications will be sent to the membership. All meetings will be held in the Auditorium of the Rundel Building, Rochester Public Library.

The Program Chairman, Mr. John V. Butterfield, 635 St. Paul Street, Rochester, New York, and his committee have started building the program. His first call for papers by the membership of the B.P.A. is made on page 159.

An International Exhibition of Biological Photography will take the place of the usual Salon. The International Exhibition of Biological Photography of interest to all photographers in the scientific field will be held September 10-27, 1947 under the sponsorship of the Biological Photographic Association in Rochester, New York.

The Exhibition will be on display in the beautiful gallery of the Rundel Building of the Rochester Public Library. All the facilities necessary for display in the best recommended manner are available to the Exhibition Committee. Nathan S. Horton, F.B.P.A., of New York City, is Chairman. The Co-chairman for the local arrangements is H. Lou Gibson, A.P.S.A.

The scope of the Exhibition, which will be held in conjunction with the 1947 Convention of the Biological Photographic Association, includes scientific photography of all biological subjects. The term, "biological," has been considered in its broadest sense. The major fields of medicine and natural history will constitute the majority of photographic interest. However, all aspects of biology—zoology, genetics, osteology, paleontology, etc., entymology, ornithology, ecology, and geology, as it pertains to living organisms, are subjects for exhibition. Scientific record photography is not to be ignored.

The desire of the Exhibition Committee is to include all photographic technics in the preparation of black-and-white and color still and motion-picture photographic material. The technical procedures desired are those of general photography, photomicrography (electron and visible light, radiography (except as applied in routine roentgenography), autoradiography, microradiography, electron diffraction of animal or plant tissues, high-speed photography, infrared, ultraviolet, polarized light records, etc.

Three prominent judges in their fields will select all entries:

Arthur A. Proetz, M.D., F.B.P.A., the distinguished editor of The Annals of Otology, Rhinology, and Laryngology, an enthusiastic biological photographer in connection with his own practice, particularly stop-motion photomicrography.

Walter Clark, Ph.D., F.R.P.S., F.P.S.A., Technical Assistant to the Director of the Kodak Research Laboratories and an outstanding authority in the field of scientific photography.

Leo C. Massopust, F.B.P.A., Editor of the Journal of The Biological Photographic Association and a biological photographer in the School of Medicine, Marquette University, who has shown extensive interest in the application of infrared and x-rays to biological subjects in the fields of physiology and pathology.

Membership in the Biological Photographic Association is *not* a requisite for participation in the Exhibition.

Every member of the B.P.A. is urged to contribute to the Exhibition. Entry blanks will be mailed to all subscribers of this Journal. Obviously, this includes all members of the Association. Non-members may obtain entry blanks upon request to Mr. Nathan S. Horton, 22 East 40th Street, New York City or Mr. H. Lou Gibson, 343 State Street, Rochester 4, New York.

The last day for receiving entries is August 1, 1947.

The JOURNAL of the Biological Photographic Association

Volume 15 • MARCH, 1947 • Number 3

Official Publication of the Biological Photographic Association

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Leo C. Massopust, Editor

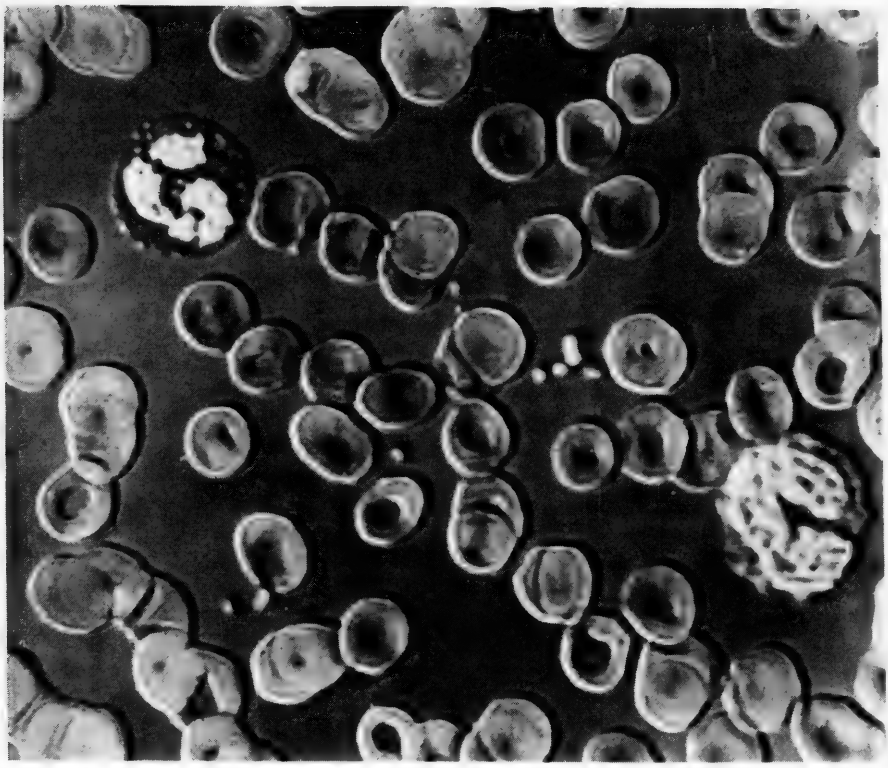
Marquette University School of Medicine

Milwaukee 3, Wisconsin

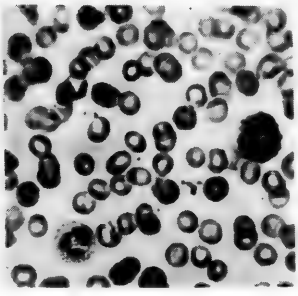
ASSOCIATE EDITORS

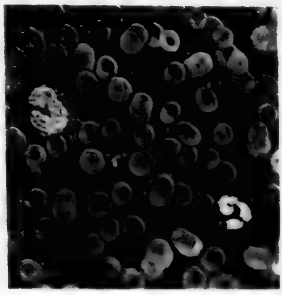
ARTHUR W. PROETZ, M.D., Beaumont Building, St. Louis, Mo.; ANNE SHIRAS, School of Medicine, University of Pittsburgh, Pa.; FERDINAND HARDING, The Children's Hospital, Boston, Mass.; and ARTHUR W. FUCHS, 164 Inglewood Drive, Rochester, N. Y.

Published Quarterly at 561 North 15th Street, Milwaukee 3, Wisconsin. Entered at the Post Office, Milwaukee, Wisconsin, under the act of March 3, 1879. Subscription price $3.00 per volume; foreign countries $3.50. Single copies 75 cents in U. S. A.



Photomicrograph 900X Oil immersion. Normal bone marrow—showing use of bas-relief technique to demonstrate third dimension of blood cells for teaching purposes. Negative made on Contrast Process Panchromatic film without filter. Positive made on Contrast Process Ortho film. Allen F. Hancock, Division of Hematology, Charlotte Drake Cardeza Foundation, Jefferson Medical College and Hospital.





Photography of Fluorescent Phenomena

By G. L. Royer and C. Maresh
Microscopical Laboratory
Calco Chemical Division
American Cyanamid Company
Bound Brook, New Jersey

A NUMBER of papers have been written on fluorescence microscopy and photomicrography of which those by Jenkins (1), Richards, et al (2), Graham (3), Loewenstein, et al (4), Dempsey (5), and Ellinger (6) are a few. They describe special staining techniques and methods for the application of fluorescence microscopy to histological problems. Benedik (7) in a paper on luminography described some of the early work in the medical field using black and white macro photography. Figge (8) has discussed fluorescence as an aid to discovery and diagnosis in medicine and with Clarke (9) has published a paper on the photography of fluorescence phenomena with Kodachrome color film. Radley and Grant (10) in their book discuss many phases of fluoresence.

In this paper the subject will be discussed from the general viewpoint of the techniques involved in making photomicrographs and macrophotographs. The color photographs which accompanied the presentation of this paper at the Chicago meeting of the Biological Photographers Association in September, 1946, were to show the results of using these techniques to illustrate the many uses of fluorescent phenomena. Because of some differences in techniques the macrophotography will be discussed first and this will be followed by a description of the methods used in photomicrography.

General Discussion of Luminescence

Fluorescence may be defined as the phenomenon that occurs when radiation of one wave length falls upon a substance and is changed to radiation of the same or longer wave length. For most practical purposes and as considered in this paper it is the changing of ultraviolet light whose wave length is below the visual violet to wave lengths within the visual spectrum. In other words it is the transformation of invisible "black light" into beautiful colors. The colors that become visible depend upon the composition and nature of the

Received for publication December 2, 1946.

substance which produces the change and to some extent upon the wave length of the ultra-violet. With fluorescent substances the excitation lasts only while the invisible ultra-violet energy is falling upon the subject. However, some substances will be found that will continue to glow after the exciting energy is turned off and these are said to be phosphorescent. The general term describing both of these phenomena which change one form of light energy into another is luminescence. Phosphorescence can be photographed but since it tends to fade quickly after the exciting source is removed, the intensity of the emitted light is very weak and very long or repeated exposures are needed to build up a photographic image. Therefore, in this article the material presented will be restricted to fluorescent phenomena in which the subject is excited with "black light" of the near ultra-violet containing little or no visual light.

Macro Fluorescence Photography

The color photography of fluorescent subjects which can be taken with the usual camera lenses will be described here. This may be reproduction in reduced size, or may be low magnification. The magnification or reduction will depend upon the size of the object, the size of the film and the detail to be shown. The detail to be illustrated is the important factor and when this has been determined the camera is set up so that the proper image will be obtained. Obviously this can be done by visual light and the technique is the same as customarily used in macro and small object photography. Extension bellows are necessary for low magnifications and close up views. Once the conditions for the picture have been established the apparatus must be arranged for fluorescence photography.

Ultra-violet Sources

The source of the ultra-violet light is the first important part of the apparatus. The source should be strong in the ultra-violet portion of the spectrum and preferably low in visible light. The visual light is removed by a suitable filter which will be discussed later but the greater the ratio of ultra-violet to visible light the better the results that can be obtained. Carbon arc lamps using electrodes filled with chemical elements which give a rich ultra-violet spectrum are quite satisfactory except that they are also high in visual and heat rays which must be filtered out. These present some problems of breakage of the glass filters which because of their composition are not very stable to heat. Operating difficulties in keeping arc lamps steady also deter their use.

Vapor discharge, particularly mercury vapor, lamps are quite suitable. Some of these are discharges in quartz tubes. Quartz lamps pass

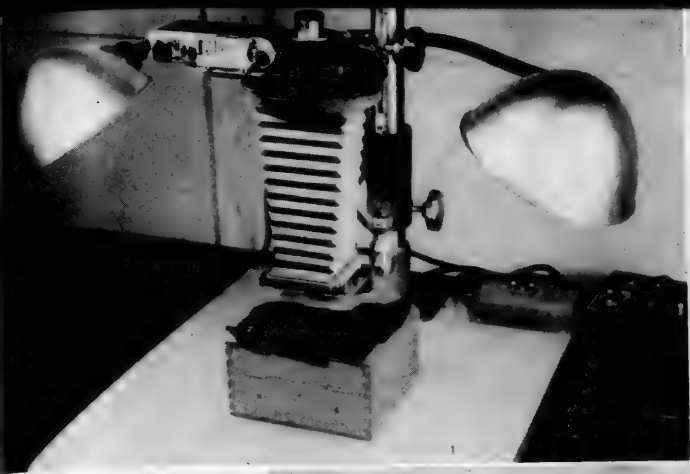


FIGURE 2

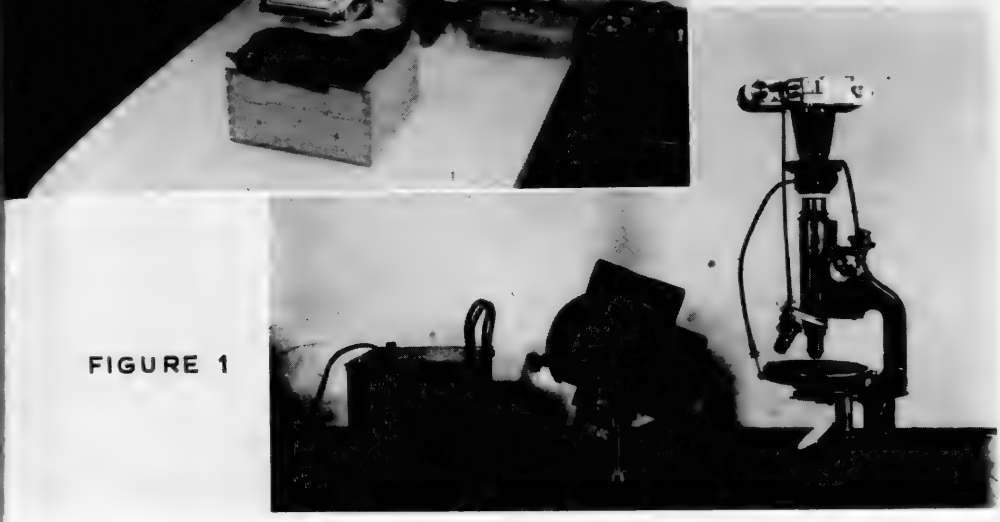


FIGURE 1

Figure 1. H-3 lamp used in a Spencer model 370 microscope.
Figure 2. Kodak precision enlarger set up as a camera.

more and shorter wave lengths of ultra-violet but if the final ultra-violet light is filtered by glass filters to remove the visible light, it would not seem necessary to have quartz lamps for general fluorescent work. However, cold quartz lamps are a satisfactory source. The cost is usually greater but in some cases they do give a different color fluorescence because of their spectral distribution. The A-H4 lamp made by Westinghouse and General Electric is a 100 watt special glass enclosed lamp which fits into the admedium screw base socket and operates from a transformer. This lamp has replaced the H-3 lamp which has been used in our laboratory for most of our work. It is assumed that the A-H4 lamp is superior to the H-3. Figure 1 shows the H-3 lamp used in a Spencer Model 370 microscope lamp housing (American Optical Company, Buffalo, N.Y.). The glass condenser with an iris makes it possible to use this set-up the same as in visible light. This has been used for the illumination of small areas for small object fluorescent photography and also for photomicrographic work to be described later. A B-H4 lamp is available and it is similar to the A-H4 but its outer bulb is made from a glass which filters out most of the visible light.

The 1000 watt H-6 water cooled quartz capillary mercury lamp described by Noel (11) was available and made a satisfactory source. However, this lamp has been replaced by the A-H6 and B-H6 which are also 1000 watt lamps operated with special transformers. The A-H6 is water cooled while the B-H6 is air cooled. These require special

safety controls due to the high voltage and the necessity for cooling and for this reason are difficult to set-up and operate. However, the source is intense and useful for fluorescent photography.

Argon glow lamps are another source of ultra-violet. Their original cost and operation is low and the intensity of the ultra-violet is not strong. However, a number of them can be distributed to illuminate large areas and used for photography but the exposures required are quite long.

A light source of interest in macro fluorescence photography is filtered tungsten light or the so-called "Purple X"' bulb which is similar to the well known No. 1 photoflood except that the envelope is made from glass which serves as a filter to remove a certain amount of the visible light but still transmits the ultra-violet. The "Purple X" gives a high percentage of visible light in the red part of the visible spectrum. Care must be exercised in using this lamp because it floods everything with visible red light which may be mistaken for true fluorescence. As with the photoflood lamps these lamps burn at a higher amperage than the normal tungsten lamp and thus give off much more energy. Because of this their life is short and because of the heat absorbed by the filter glass, they can be used only for intermittent periods of less than 10 minutes or the glass will soften and collapse. They can be used in reflectors and adjusted to illuminate subjects in the same way as photoflood lamps. Figure 2 shows the Kodak precision enlarger set up as a camera with "Purple X" bulbs in the reflectors for fluorescent photography. A Leica camera with the sliding copying attachment has been adapted for use with this set-up. This versatile apparatus can also be adapted for professional cut film of several sizes. Thus the "Purple X" lamps can be used to cover rather large areas or if used up close they serve as adequate illumination for low magnifications.

Filters for Absorbing Visible Light

In order to separate the ultra-violet light from the sources that have been described, except for the "Purple X" bulbs, it is necessary to use filters which will absorb or remove the visible light but transmit or pass the ultra-violet light. Some chemicals in solution such as nitrosodimethylaniline can be used as liquid filters but the glass filters are more satisfactory. These are available from the Corning Glass Works as "Ultra-violet transmitting glasses" and are made in several types having different transmitting properties. Figure 3 taken from their booklet on "Glass Color Filters" shows how the transmission characteristics of the filters vary in the different portions of the spectrum. No. 5860(586*) cuts out most of the visible light and is useful for the observation of low fluorescence when absolute darkness is necessary.

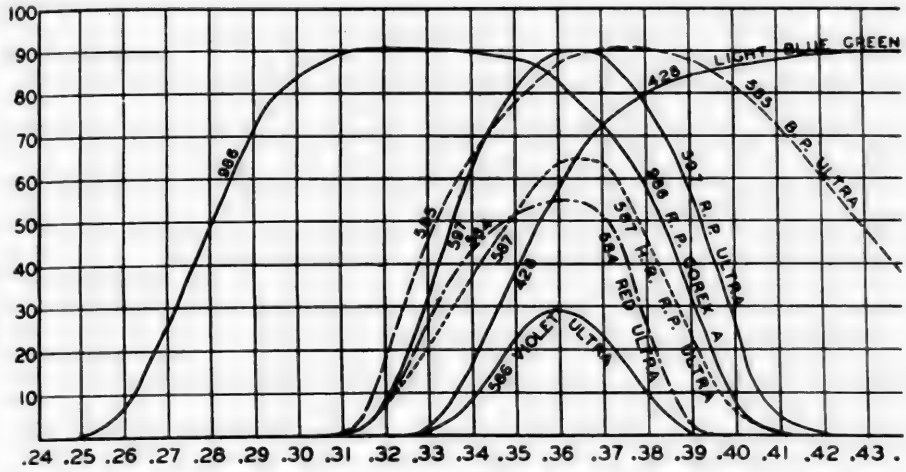


Figure 3. Variance of the transmission characteristics of the filters.

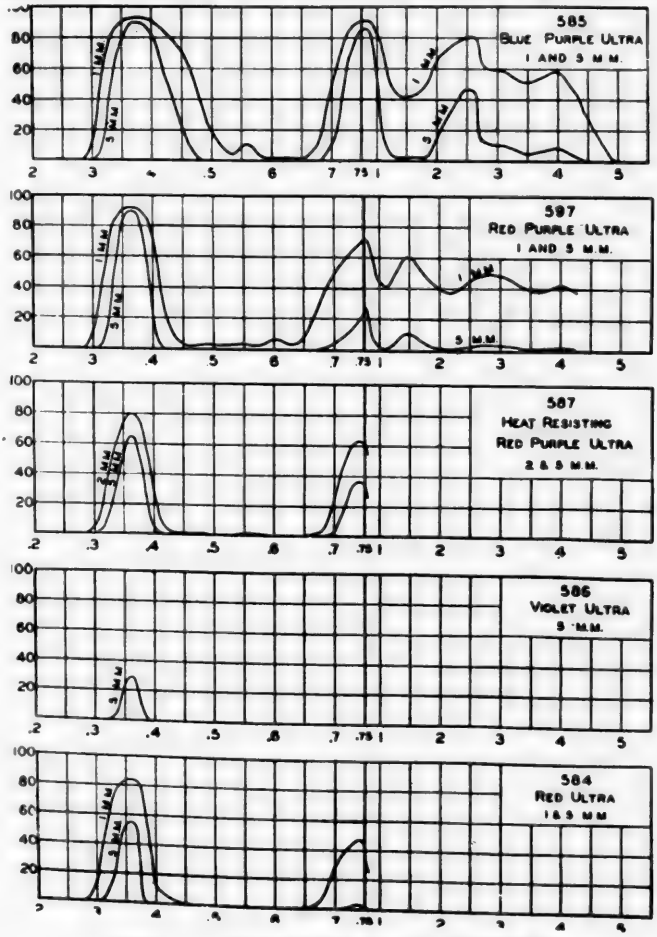


Figure 4. Chart showing the red transmission.

Its transmission is highest at about 360-370 millimicrons so it is effective in transmitting the 365 mercury line. Higher transmission of the ultra-violet can be obtained with the other filters shown in Figure 3 but they then pass some visible blue and red. Figure 4 from the Corning literature, for example, shows the red transmission for No. 5970 (597). To reduce the intensity of this visual red, the light shade blue green filter No. 4308(428) can be used. Thus the 5860(586) and 4308(428) probably give the purest filtered ultra-violet while the 5860(586) alone is nearly the same except for a slight transmission of visible red. The 5874(587) and 5970(597) used with the 4308 (428) pass more ultra-violet but also some visible violet and if used without the 4308(428) a considerable amount of visible red. The 5879(587) is more heat resistant than the 5970(597) and while it transmits less it can be used with more intense sources without thermal breakage. Somewhat similar Jena filters were available from abroad before the war and other glass filters known as "Woods filters" may be available from other sources.

Filters to Absorb Ultra-Violet Light

Another filter is necessary for safe observation and for photography of fluorescence phenomena. An ultra-violet absorbing filter must be placed between the fluorescing substance and the eye or the photographic film to remove all of the ultra-violet light reflected or transmitted by the subject or the surrounding area. Some wave lengths of ultra-violet, particularly the short ones, are damaging to the eye and this along with the intensity and time of observation should be kept in mind in regard to safety. If the ultra-violet absorbing filter is not used in photography the ultra-violet light will expose the film the same as visible light and the low intensity fluorescent visible light will be masked. Ultra-violet absorbing but visible transmitting filters are available as glass and as gelatin films. Richards (12) states that the Polaroid Company of Cambridge, Massachusetts, makes a nearly colorless filter which is satisfactory. However, many are not suitable because they themselves fluoresce from the ultra-violet light that they absorb and this causes an over-all haze to the image which is detrimental when photographing low intensity fluorescent subjects. The Eastman Kodak Wratten filter No. 85 which is used in Kodachrome photography to photograph in daylight with type A or photoflood sensitive film has been found to be satisfactory to remove the ultra-violet and it is not fluorescent. This filter when used with the type A Kodachrome gave the most satisfactory color reproduction. If reasoning is correct the No. 85B filter should be suitable for use with the

* Filter numbers in parenthesis are the old Corning catalogue numbers.

type B Kodachrome or with Ansco Color tungsten type. With daylight sensitive color film the results should be too red or yellow. With this film some other filter which absorbs less visible blue and only the ultra-violet must be used. Some fluorescent colors are not reproduced too well but this is also known to be true of some colors by regular color photography. In use in the photographic set-up the filters are inserted in the optical path where they will least affect the critical focus, i.e. in front of the lens in macro photography and just above the microscope eyepiece in photomicrography.

Determination of Exposure Time

Because of the low intensity of fluorescence the exposure times are much longer than for normal photography and they extend over quite a range because of the variation in the intensity of the light from various subjects. The fluorescent object is self-luminous and as such the subject is not being viewed by the normal methods of absorption, refraction, or reflection of light but by viewing the light itself. It is similar to viewing the wire filament of an electric lamp except that the brightness is very much less. In other words you do not see the subject but only the light that the subject produces by changing the ultra-violet light to visible light. Thus the fluorescent image looks different than the same subject viewed by regular illumination. The intensity of the light varies with the quantity of fluorescent material that is present and also with the efficiency of the material to convert the ultra-violet to visible light. Of course, the intensity of the source and the absorption properties of the filters used are also important factors in establishing the exposure time.

In a previous publication (13) a photoelectric method for the determination of exposure times for color photography was described. This same sensitive meter has been successfully used on specimens which show rather brilliant fluorescence. A description of the technique which follows has been found useful in macro or small object photography when photographing fluorescent dyed textiles in which "Purple X" bulbs were used for illumination. The set-up shown in Figure 2 was used with the "Purple X" bulbs in the reflectors. The Wratten No. 85 filter was in place over the Leica 50 mm. f2 Sumar Lens and the film used in the Leica camera was 35 mm. Kodachrome type A. In order to determine the exposure, a fluorescent dyed piece of cloth was put in place of the subject so that the entire field was illuminated with about the same intensity per unit area as from the subject to be photographed. The photocell was placed over the ground glass and the galvanometer reading taken. This value can serve as a standard reading to be used in setting up the equipment from time to time and by a series of test

exposures it can be used to establish the correct exposure for all fluorescent subjects whose intensity per unit area lies within the range for this light level. As was stated, the intensities of fluorescent subjects vary over a wide range so that this method is applicable only when using fluorescent materials of about the same brightness. The reading from the subject itself can be used if it fills the field taken in by the photocell but in the case of most subjects there is usually a great deal of non-fluorescing background and only small localized bright areas so that it is difficult to obtain the exposures for these highlights with this type of exposure meter.

A small visual photometer originally mentioned by Loveland (14) and recently suggested by Richards (15) should be quite well suited to measurements of small areas on the ground glass. Correlation with trial exposures would be necessary to establish the correct exposure levels. With the long times of exposure needed for the low intensities of many fluorescent subjects, it must be remembered that the reciprocity law does not hold. That is, a long time of exposure at low light levels does not give the same result as the same amount of light energy exposed for a short period. Color films are balanced for normal light levels and exposures, and when the exposure range is greatly prolonged the color balance may be off. However, with all of these complicating factors, satisfactory color results have been obtained covering a range of fluorescent intensities requiring exposures of 2 seconds to 40 minutes.

An example of fluorescent photography of a textile fabric dyed with a fluorescent dye is given to show a brief description of the conditions and the time of exposure. Two "Purple X" bulbs were used in the set-up shown in Figure 2. The lamps were about 20 inches from the textile material and at an angle of about 45°. The Leica lens set at f3.0 was used with the proper extension to give the desired image on the film. An Eastman Kodak Wratten No. 85 filter was placed over the lens. Type A Kodachrome film was used in the camera. A reading of 160 cm. (13) was obtained on our galvanometer from the photocell reading off of a standard fluorescent yellow dyed cloth. Exposures were made at 10, 20 and 40 seconds. The 20 second exposure being the best for this particular subject.

Applications of Fluorescence

The macro and small object color photographic technique just described can be used to record many fluorescent phenomena. Active mildew on wool can be distinguished by its brighter fluorescence over that of the wool itself or from stains or areas which have become inactive. This test can be used to detect damage and thus prevent the destruction of wool while in storage. Many dyes are fluorescent and can be used

to make designs for theatrical or display purposes. Fluorescent dyed objects illuminated by "black light" keep the level of general illumination low since only the objects themselves glow. For example, patents (U.S.P. 2,169,657 and 2,308,423) have been issued to Millson on the use of these dyes in theater carpets and seat coverings so that the patron can walk down the aisle on a carpet of light and locate a glowing empty seat without any increase of general illumination in the theater. Fluorescent paints and inks find use on instrument panels at night when low general illumination is needed for good visibility. Secret writing inks can be fluorescent and when used can be detected and recorded by fluorescent photography. Because very small quantities of a fluorescent dye can be detected by ultra-violet light in darkness, they can be used as tracers and indicators in chemical analysis and physical experimentation. Similar quantities of visible dye can not be detected and, therefore, the fluorescent dyes have been useful in many research investigations.

Millson (16) has published several papers on fluorescence and phosphorescence showing their use in the textile industry and has given lists of dyes, intermediates, oils, fibers, etc. to show their color when exposed to "black light." A publication by the same author on blackout preparations discusses many uses of fluorescence and phosphorescence during the war years. Some of these probably will have peacetime uses.

The mineralogist has been using fluorescence for years for identifying mineral components both in polished specimens and in the field. Many minerals such as wernerite, autunite, willemite, fluorite, calcite, aragonite, sphalerite, scheelite, precious and semiopal, curtisite, dakeite are known for their brilliant fluorescence in all the colors of the rainbow. Mixtures of minerals in the same specimen make very striking effects under "black light". The usefulness of this fluorescent property lies chiefly as an aid to rapid identification of the mineral and has been an important factor in the location of tungsten ore deposits which have been a necessary part of the war effort. Certain radium-bearing minerals are also detectable by the fluorescent technique. To separate these minerals from other components of the rock formation, they are ground and removed by flotation techniques. Fluorescence is a means that can be used to follow these separations and determine their efficiency.

In the biological field fluorescent dyes have been used as tracers and stains. They can be used to trace the blood flow and movement of other liquids in various systems. As stains they can be used in a manner similar to the regular biological stains and as such can be detected in smaller quantities and give a more definite identification. Some natural products are fluorescent and give rise to fluorescence in certain portions.

As mentioned previously, some mildews are fluorescent while active, and non-fluorescent if inactive. Benedik (7) reports on the luminescence of some types of dermatitis. It would seem that some of these techniques would be more useful in the biological field if they were better known.

Microscopical Fluorescence Photography

Most of the subjects which exhibit fluorescence can usually be examined at higher magnifications in order to study their detail. For example, one can look at a fluorescent textile material to see how the dye has penetrated into the individual fibers which make up the fabric. The distribution of the dye from fiber to fiber gives information about the differences between fibers. Higher magnifications of the single fiber itself shows up differences in the structure which are useful in the fundamental study of dyeing itself. As mentioned in the introduction of this paper a number of authors have reported on the biological uses of fluorescence microscopy. The color photomicrographic techniques described here should be useful in recording in color these known procedures as well as others which may be developed from time to time.

Fluorescent Microscopical Equipment

The light sources and filters described under macro photography apply in general to fluorescent microscopical work. The capillary type mercury arcs such as the H-3, A-H4 and A-H6 lamps described earlier in this paper can be used for microscopical studies. High energy is concentrated in the small area of the source so that the illumination is high per unit area. The length of the source makes it difficult to use the entire capillary to the greatest efficiency without the use of specially designed lenses. However, a portion of the source can be used satisfactorily. A condenser system with the A-H4 or A-H6 lamps such as is shown in Figure 1 along with the microscope condenser makes possible both Koehler or Critical methods of microscopical illumination. These condensers can be made of quartz for better transmission of ultra-violet light, but it has not been found to be of any marked advantage for the range of wave lengths of ultra-violet passed by the glass filters that are used. In using the A-H3 or A-H6 lamps the Corning filter 5860(586) along with a 4308(428) filter gives the field most free of visible light. As discussed previously, a number of other filters are available to give more ultra-violet and also more or less visible blue or red, or both. A high ultra-violet reflecting mirror may be used in place of the regular glass mirror on the microscope if maximum intensity is desired.

In the technique just described the regular transmission microscope system was used. Systems for reflected light such as the Epi illuminator of Zeiss or the Ultrapak of Leitz can also be used. Some of these

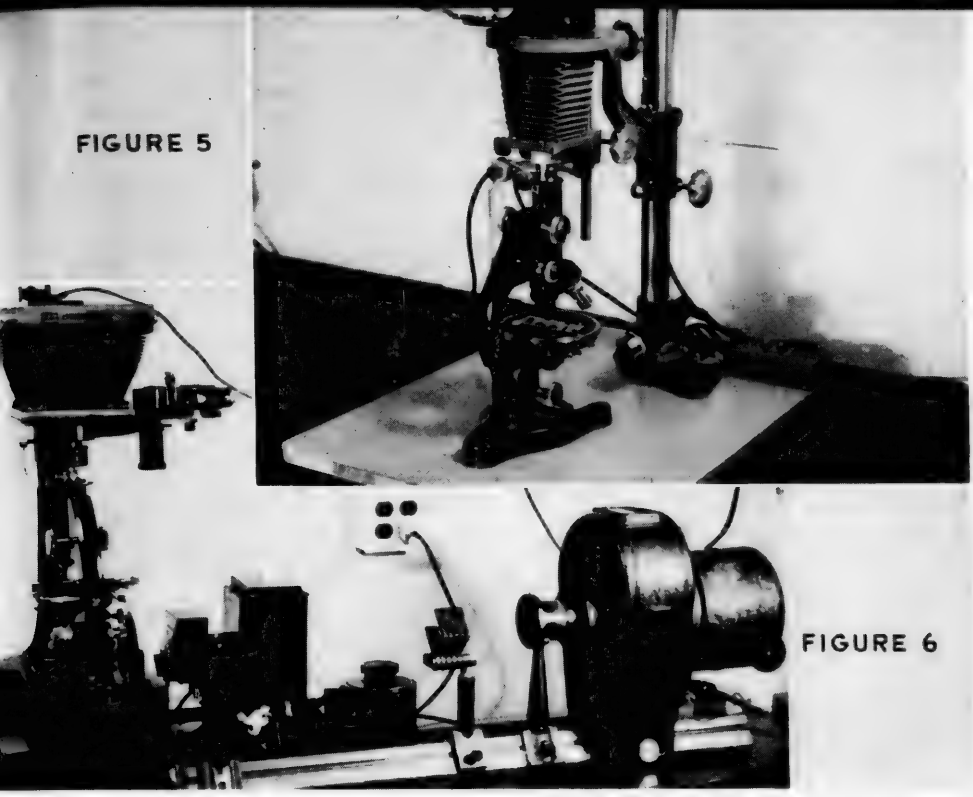


Figure 5. Kodak precision enlarger.
Figure 6. Optical bench set up for photomicrography.

have been made with special quartz systems for this purpose. It is reported that the glass systems are transparent to about 310 mu and, therefore, will not absorb too much of the near ultra-violet and can be used for a reflected light fluorescent system. It is not necessary to use as efficiently filtered ultra-violet light since the background will not reflect as much into the field as will be transmitted through with the regular microscope. If the intensity of the fluorescent light is much greater than the ultra-violet that is reflected, an ultra-violet eliminating filter will not be needed. The Wratten No. 85 filter which was recommended above transmits about 65 per cent of visible light and, therefore, to be sure that no reflected ultra-violet light is recorded it should be used. However, with some specimens it will not be needed if a reflected light microscope system is used, but trial will be necessary to determine the experimental conditions. Except for a decrease in exposure time no advantage is gained if it is not used, and the method is always open to the criticism that some ultra-violet light is being recorded as fluorescent light.

It is not the purpose of this paper to discuss photomicrographic equipment as any well designed apparatus and microscope can be used as long as the proper light source, filters, and color film are chosen. It may be as simple as the adaptation of the Kodak precision enlarger as shown in Figure 5, or it may be arranged on an optical bench which is permanently set up only for photomicrography as can be seen in Figure 6.

The previous discussion on the determination of exposure for low power or small object fluorescent photography is in principle applicable to photomicrographic studies. The same range of intensities exist, and the problem of partial field coverage brings the same complications to the application of photoelectric methods. In place of the fluorescent cloth which was described as a standard in macro photography, a standard fluorescent microscope slide has been used. This slide has been prepared to have a permanent mount of a uniformly distributed fluorescent dye. It serves as a standard for duplicating the setting up of the apparatus and for establishing the exposure values for substances which have similar intensities of fluorescence. This procedure has found use in our laboratory on substances which are more or less similar in the intensity of fluorescence. However, for a method to cover a wider range of intensities the methods of Loveland and Richards discussed before should be investigated. An example of fluorescent microscopy using the apparatus shown in Figure 1 is given for illustration of the times of exposure. An Eastman Kodak Wratten No. 85 filter was inserted between the eyepiece and the film. 35 mm. Kodachrome Type A film was used. The lamp was the old H-3 and the filters used on the lamp were Corning 5840(584) and 4308(428). The subject was human hair which was fluorescent due to dermatitis (7) and was furnished by Benedik. With a 10X objective and 10X eyepiece and an extension of 10 cm. the exposure of about 10-20 minutes was adequate. A lower magnification with a 3.2X objective and 10X eyepiece reuired about the same time.

Conclusion

The photography of fluorescent objects both macro and through the microscope offers an opportunity for color reproduction of many beautiful phenomena. Many of the colors are brilliant and in combinations which are in striking contrast to their dull appearance in normal light. In addition to beauty, the usefulness of fluorescent phenomena is increasing in research and industry. While most of the work done in this laboratory has been in the fields of textiles, mineralogy, paints, pharmaceuticals, and dyes, the same techniques should be applicable to medical and biological investigations.

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American Standard Association

Conversion Tables. American Standard Practice for Conversions of Weights and Measures for Photographic Use, Z38.8.2-1945 (price—10 cents) consists of two pages printed on one sheet of paper which can be trimmed to 7½ x 10½ inches. This standard also contains conversion factors for weights *and* measures; grains per U.S. quart to grams per liter, etc. As many photographic formulae are still published in only one system, it is often necessary to convert to the system in use in the chemical mixing room. If two copies of the standard are purchased, the obverse side of one can be mounted on the left and the reverse side of the other on the right, giving a mount about 15 x 10½ inches which contains all the information. This can be framed and hung on the wall of the chemical mixing room. The type is large enough to be read across a laboratory bench, and with the information on the wall it will be easy for the photographer to convert formulae from one system to another without having to handle books which might be in the way on the bench.

Accuracy of Chemical Apparatus. The American Standard for Accuracy of Scales, Graduates, and Thermometers for Use in Photography, Z38.8.9-1946 (price—15 cents) gives tolerances which are satisfactory for most photographic purposes, but mentions that they may not be satisfactory for commercial purposes or precision laboratory work. For instance, thermometers are allowed a tolerance of ±1 F in the range from 60 F to 90 F (0.5 C in the range from 15 C to 32 C). In the Ektachrome process, however, the temperature of one solution must be maintained within a tolerance of ±0.5 F, and a more accurate thermometer is needed. Other than this one instance, the tolerances seem to be satisfactory for most work in biological photography.

LOUIS PAUL FLORY,
Yonkers, N.Y.
BPA Representative.

Photography of the Oral Cavity

William F. Payne
Roswell Park Memorial Institute
Buffalo, N.Y., Louis C. Kress, M.D., Director

THE use of photographs of the oral cavity in hospitals, teaching or research institutions, and in public health education are of limitless value. In a teaching institution, they afford the instructor a recording medium that is only surpassed by the demonstration of the actual case. In one sense of the word, pictures are even superior to seeing the actual case, because with a series of photographs, the student sees the records of the patient before and after treatment. The author once heard this statement made by an eminent public health authority, "The highest percent of malignancies occurring in patients living in India are found in the oral cavity; they even exceed carcinoma of the breast and uterus in that country." In the United States, this is just reversed. In fact, authorities state that carcinoma seldom occurs in the oral cavity if good hygiene is maintained. One could almost be so bold as to say "here is an anatomical site in which cancer could be considered preventable."

Photographs of the oral cavity supply the doctor or dentist with records of the progress of the patient and perhaps at a later date when the results are summarized, illustrations of the effect of a given treatment can be evaluated. In the field of Public Health Education, photographs are of the utmost value in dispelling fear of a certain disease. The laity can see with the aid of photographs the results of neglect as well as what has been accomplished by adequate treatment.

At times, it is difficult to obtain a photograph of the oral cavity. The pathology present may make it difficult for the patient to open his or her mouth wide enough to make a satisfactory exposure. Again some patients gag very easily, making it necessary to depress the tongue in order to prevent it from masking the photographic field. This is true when making a picture of the tonsils or pharynx. In this type of patient a local anesthetic of one percent pontocaine can be administered by a doctor or dentist, which will overcome this reflex. Another way of overcoming this gagging is to allow the patient to place a five gram Biscolax tablet on his tongue about ten minutes previous to making the exposure. However this Biscolax tablet is white and leaves a white deposit on the tongue, which is objectionable in the finished photograph.

Received for publication December 4, 1946

Figure 1. Nose and throat examining chair.

This can be obviated by allowing the patient to rinse the mouth with water prior to making the exposure. This will not interfere with the anesthetic effect. Dentists have found Biscolax useful in taking intra-oral x-ray films of nervous patients. It will take fully ten minutes for this drug to produce its effect. It must be pointed out to the patient that the tablet must be allowed to dissolve on the tongue and not swallowed. However, pontocaine is preferred because it produces a quicker effect. But since it must be administered by either a physician or a dentist, Biscolax is a good substitute when neither of these men are available.

Three primary factors are necessary to make good pictures of the oral cavity. First, a head rest that will support the patient's head and keep it in the desired position. Second, instruments that will produce a good exposure so that the lesion can be seen. Third, a light that will supply sufficient illumination. The camera and the type of film are secondary.

Most institutions have a man who can make a head rest for this type of work. It is strongly recommended that the head rest be attached to the chair in which the patient will sit. The one which is recommended by the author is a nose and throat examining chair. It is of all metal construction with a head rest attached and an adjustable back, figure 1. The seat is of metal with a screw spindle, which makes it possible to lower and raise the seat to accommodate different patients. In figure 1, (A) is the head rest which is adjustable, (B) two adjustable arm supports which have been found very useful, especially in photographing youngsters, as they act as restraining straps to keep the patient fixed. (C) is a ½ inch rod attached to the back of the chair which

with the aid of the swivel will hold a dental mirror which is necessary in some cases, (D) dental mirror, (E) camera, (F) the light reflector with flash bulb in place, which will be discussed later.

The cost of the metal chair is incidental compared with the convenience and use to which it can be placed, not only in oral but in other types of photography. It is strongly advised to obtain a chair of this type as it is important and essential for good photography.

In order to photograph a lesion in the oral cavity, it must be visualized clearly. For this reason, some type of instrument must be employed which will keep the mouth open wide. In many cases a single instrument will not suffice to overcome all difficulties. Hence the nominal cost of several of these devices necessary to do good work is well worth while. Every instrument should be self-retaining if possible. When this is not possible, the patient should assist in obtaining good retraction. Such cooperation by the patient produces more satisfactory results. A very sick patient will require the aid of a nurse or an assistant. A good example of this cooperation is in photographing a tongue, especially when the lesion is located on the dorsum. Two instruments are necessary, one to open the mouth wide and the second to retract the tongue itself. If the gag used to hold the mouth open is self-retaining, the second instrument, a tongue forceps, can be manipulated by the patient. After the gag has been inserted into the mouth, the tongue forceps is clamped onto the tongue and the patient is asked to pull the tongue out as far as possible. It is, at times, surprising how far the patient will retract the tongue and yet when a nurse or an assistant does it the patient will complain.

The author recommends that the patient be allowed to assist whenever possible, as experience has proven that better exposures can be obtained with the patient's cooperation.

Figure 2 shows the instruments which have been found very useful at the Institute. Number 1 is a Bozeman serrated jaw uterine dressing forceps. It is 10½ inches long and is very useful in sponging or swabbing a bleeding lesion. Its long handle will be found very useful for other purposes. Number 2 is a right angle tongue depressor. This right angle feature is very important for with it the proper amount of pressure can be brought to bear on the tongue while the hand holding the instrument remains outside the photographic field. If this depressor were made of solid metal there would be a greater reflecting surface. Number 3 is a Columbia lip retractor. It is suggested that every laboratory procure at least two of these. This instrument has many uses. It has two ends which are different in size. The smaller

end is 2 inches wide and is an excellent retractor for a child's mouth while the larger size at the opposite end is 2½ inches wide and is used for the adult mouth. It will be noted in the clinical pictures that this retractor is easily managed by the patient. Numbers 4, 5, and 6 are mirrors. Number 4 is a 2 inch mirror with a handle, number 5 is a 1½ inch mirror with a handle and number 6 is a 1 inch mirror without a handle. The mirrors are threaded at the distal end and are screwed into the handle. Number 7 is a Young's seizing forceps with rubber jaws and is very useful in retracting the tongue. The jaws are small and do not cover too much of the tongue. Number 8 is a very useful mouth gag and one that is absolutely self-retaining. It is the Hu-Friedy

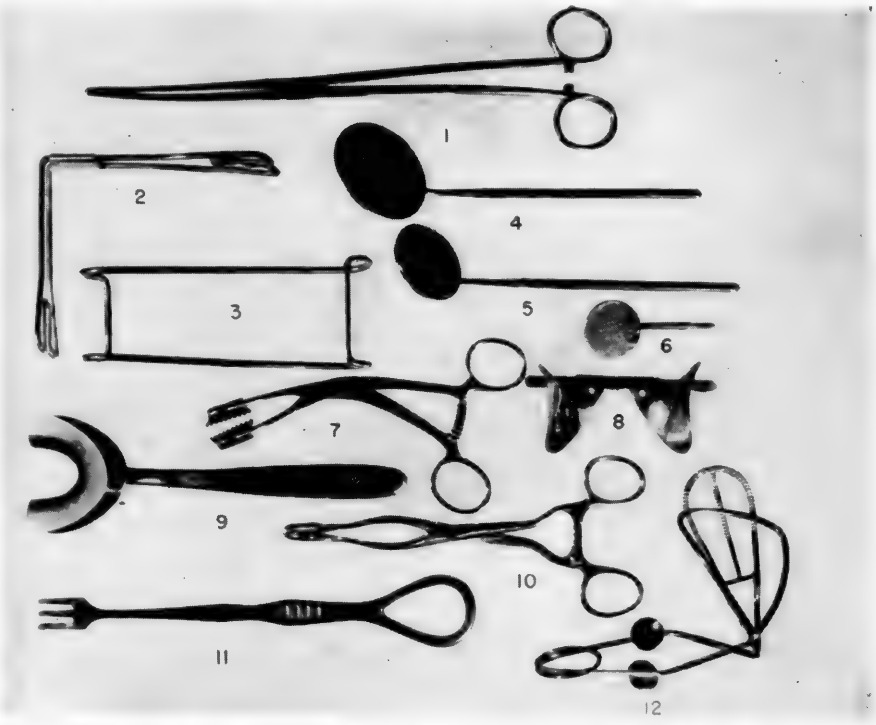

Figure 2. Instruments useful in photographing the oral cavity.

oral speculum which keeps the mouth wide open without any assistance and is not uncomfortable. Number 9 is a cheek retractor. Number 10 is a Collins small jaw seizing forceps which is also a good tongue retractor. Number 11 is a Volkmann's ring handle three-prong blunt retractor, which has many uses. It is small and the blunt prongs do not

cover too much of the surrounding tissue and most important are not uncomfortable to the patient. It is again recommended to procure two of these retractors, as most times when using these retractors, it will be desirable to obtain retraction in two directions. Number 12 is another tongue depressor which is equipped with a spring attached to the chin rest, making it self-retaining. However, it is limited to the pressure it will apply to the tongue. The number 2 tongue depressor is superior to this number 12.

All of the instruments used by the author are shown in figure 2. The important ones are listed in the order of their use: two each of number 3 and number 11, one of each of the following, numbers 8, 2 and 7. If mirrors are necessary, numbers 6, 5 and 4.

Mirrors are necessary to obtain some pictures in the oral cavity. In figure 2, numbers 4, 5 and 6 are special mirrors. The ordinary dental mirror is a second surface mirror; that is, the silver coating or the reflecting surface is one the lower or second surface of the glass. With this type of mirror, two reflections are often obtained, one from the top or first surface, and the second reflection from the bottom or second surface. Again, most dental mirrors have a concave surface and do not give a true reflection of what is being photographed. This is especially true when purchasing mirrors larger than 1 inch in diameter. It is strongly recommended not to use a second surface mirror. The three mirrors, mentioned above, are optically flat pieces of glass on which has been sputtered an aluminum coating. The coating of these mirrors was done by the Aluminum Films Corporation of Ithica, New York. This sputtering is coated on the top or first surface which permits a perfect reflection of the object to be photographed, and eliminates distortion and fuzziness that would result with a second surface mirror. This sputtering method will give almost 88 per cent reflection which is more reflection than obtained from a silver coating. However, it will not withstand steam sterilization, hence the Bard-Parker solution is suggested for sterilization. Extreme care must be used in handling as well as sterilizing these mirrors. Since the aluminum sputtering is on the first surface it will scratch very easily. Naturally, these scratches will show, necessitating the resurfacing of the mirror.

Mirrors are necessary when photographing: the anterior teeth, the labial aspect of the molar teeth, as well as under the tongue in the floor of the mouth. When a mirror is used, the temperature of the mirror must be equal to the temperature of the patient's mouth for condensation will form on the mirror which will make it impossible to obtain a clear reflection on the mirror. This can be avoided by heating the

mirror in the flame of a small alcohol lamp and then testing on the back of the hand. If the hand can withstand the warm mirror, it is a good indication that the mirror is not too hot for the patient's mouth.

Illumination

For all photographs in the oral cavity, regardless if color or orthochromatic films are used, flash bulbs are recommended. First, because it does away with bright lights, which give off considerable heat, and secondly because of the size of the bulb. The light from the flash bulb is intense, but the heat from this bulb is expelled within a few seconds. The flash bulb also gives sufficient antenic light to permit the use of the iris diaphragm stops of f45. when using orthochromatic films, and f16. to f22. when using Kodachrome. This is a distinct advantage as it gives much greater depth of focus. Good clinical pictures must not only have the lesion sharp and distinct, but the surrounding structures as well. The size of the lesion can often be determined by comparison with surrounding normal tissues. This is especially true in the oral cavity. A tooth, or the uvula will often provide the doctor or dentist with a comparative study of the size of the lesion. Thus, if the surrounding structures in the background are out of focus, the resulting photograph loses detail and diminishes its clinical value.

In order to produce the same intensity of light that is obtained from a flash bulb, it would require lamps of 2,000 or 3,000 watts. If the lesion is in the posterior portion of the mouth a condensing system may be required to concentrate the light. If condensers are used with high watt bulbs, there is the possibility of causing a burn of the mucous membrane of the mouth. It is true that the mucous membrane will withstand more heat than epidermis, but a burn from the improper use of condensors is very disturbing to the patient.

Most pictures of the oral cavity can be obtained without any special lighting systems. A 4 inch hand reflector with the source of electricity obtained from the house current (110 to 120 volts) to ignite the flash bulb has proved satisfactory. For a few years, a hand reflector was used with flash-light batteries concealed in the handle of the reflector, which caused the flash bulb to ignite. Far too often the button was pressed to cause the flash bulb to ignite, only to find that the batteries were exhausted. It was then necessary to remove the instruments from the patient's mouth, take out the batteries, replace them with new ones and begin all over again. The use of the 110 volt current has eliminated this difficulty. With this hand reflector the oral cavity can be easily illuminated. A 4 inch reflector is recommended, for a larger one will be difficult to keep out of the photographic field. A small hole,

¼ inch in diameter may be drilled into the reflector about 1 inch above its center; this may be used to sight the proper point necessary to illuminate the oral cavity. However, this "peep sight" can be eliminated when the operator becomes accustomed to using this 4 inch reflector and knows just where to place it in order to get the best results. Over 90 per cent of routine pictures of the oral cavity can be taken in this manner. The remaining 10 per cent may require some condenser in order to illuminate the posterior or back of the oral cavity. The method and the light that has been used for this type of case is described below.

For the actual taking of the picture, a spotlight is used to illuminate the oral cavity for the purpose of focusing on the ground glass of the camera. When the focusing has been completed, this light is turned off so that all light necessary to make an exposure is supplied by the flash bulb. This alone assures constant densities, providing the distance from the light to the object photographed is constant. This constant distance is most important and cannot be emphasized too strongly. It is still more important when color film is used. If the inverse square law is remembered, constant results will be obtained. Variation of 3 inches will be quite noticeable, especially when using Kodachrome film. With black and white film there will be considerably more latitude. Perhaps there may be some who will be of the opinion that there is a difference in the intensity of light given off from each flash bulb of the same manufacture. We have not been able to detect any differences in our results.

For the photographs of the oral cavity which cannot be taken with the 4 inch reflector mentioned above, a simple light was made. It is actually two lights with a single condenser. One light is used for focusing the image on the ground glass, then swings out of position and the second light, which is a ash bulb, automatically falls in its place and the exposure made.

Figure 3 shows a close up of four views of this light. (A) is a front view with a piece of sheet steel 5x7 inches which arts as a light shield. This piece of sheet steel is 22 gauge and is attached to a tilting device which permits the light to be tilted 180°. In the upper central part of the shield is a 2 inch hole which holds a condenser 2 inches in diameter, the focus of which is 5 inches. This condenser will produce a 4 inch circle of light when it is 14 inches from the object. It is a simple plano convex condenser, held in place by three clips and all the light supplied by the two lights passes through this condenser. The 4 inch circle which this condenser produces will be large enough to illuminate any size oral cavity. (B) is a side view of the lamp. The winged nut at the base of the lamp (1), permits tilting the lamp to

any degree desired. (2) is the focusing lamp and (4) is the push-thru switch used to set off the flash bulb. (C) is one of the rear views of the lamp. The two lamps are swung by the pivot (5). (2) is the lamp

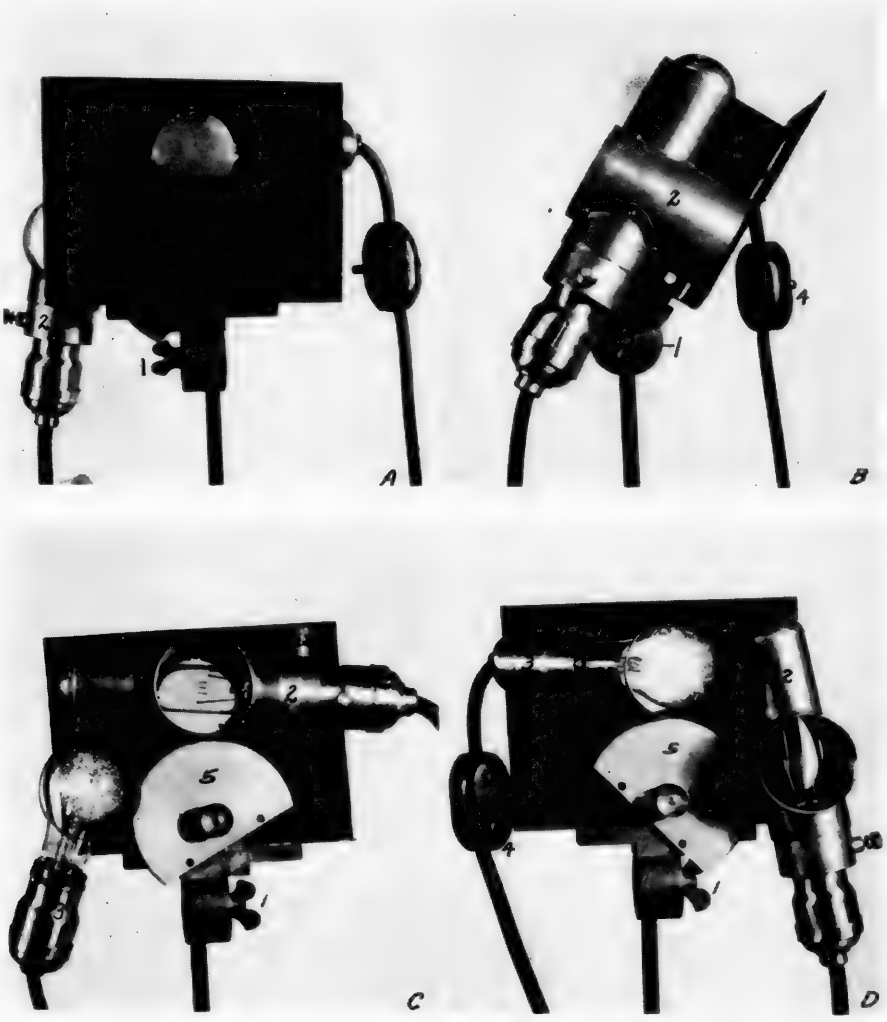

Figure 3. Four views of improvised lights.

for focusing and (2) is the lamp for the flash bulb. When taking pictures, a reflector is screwed on to the back of both lamps to get greater illumination, but in order to show detail they have been removed for this illustration. In illustration D, the other back view can be seen;

it is the same as C, with the exception of the flash bulb, which is now in place and ready for an exposure. This lamp is simple to construct and with the focusing light in place, one can readily see the size of field the condenser will cover. When the flash bulb is swung over the condenser, the same result will be obtained but the more intense light produced by the flash bulb will give increased illumination for use with the small diaphragm stops mentioned above.

The tripod used to support this light is a ⅜ inch piece of cold roll steel rod, telescoped into a ⅜ inch tubing which is supported by a 10 inch ring at the base. This base is 2 inches high, into which lead has been poured to increase its weight in order to make the tripod rigid. This base occupies little floor space, and will not interfere with the camera tripod.

When the patient is seated in the chair, the head is adjusted to the angle which clearly shows the pathological lesion. The light is then set before the patient and the distance measured from the patient to the light. The focusing light is turned on and centered so that the oral cavity is fully illuminated. This centering of the focusing light is done before any instrument is inserted into the mouth. The camera is then set in place and a rough focus is taken; that is, focused on the tongue or the anterior teeth.

The next step is the final focus. The instrument necessary to give a good operative exposure should then be inserted. When this has been accomplished, re-focus the camera, set the diaphragm stop and the shutter to "Bulb". Insert the film into the camera, turn off the focusing light, shift the flash bulb into place and make the exposure. Immediately after the patient is dismissed, replace the flash bulb with a new one. It will save time when the lamp is to be used again.

Films and Cameras

The kind of film to use is a matter of choice. There are many black and white films from which to choose. Our preference has been the Eastman SS Ortho portrait film developed for eight minutes in Eastman x-ray developer. For photography in color our preference is Kodak professional kodachrome with a 2A wratten filter. Kodachrome 828A roll film is also used in a bantam back and the exposure made without a filter.[1]

Any camera can be used; the author prefers a camera which affords ground glass focusing. The cameras used for this paper, in fact for all

[1] William F. Payne: "Clinical Photographs in Kodochrome". J. Biol. Phot. Assn. Vol. 12: 26-34, 1943.

clinical pictures in black and white, is an Eastman 5x7 Clinical camera. For color exposures, and Eastman Reccomar "33" camera is used, 3¼ x 4¼ professional type of films, while the same camera was used with a bantam back for the 828A Kodachrome roll film.

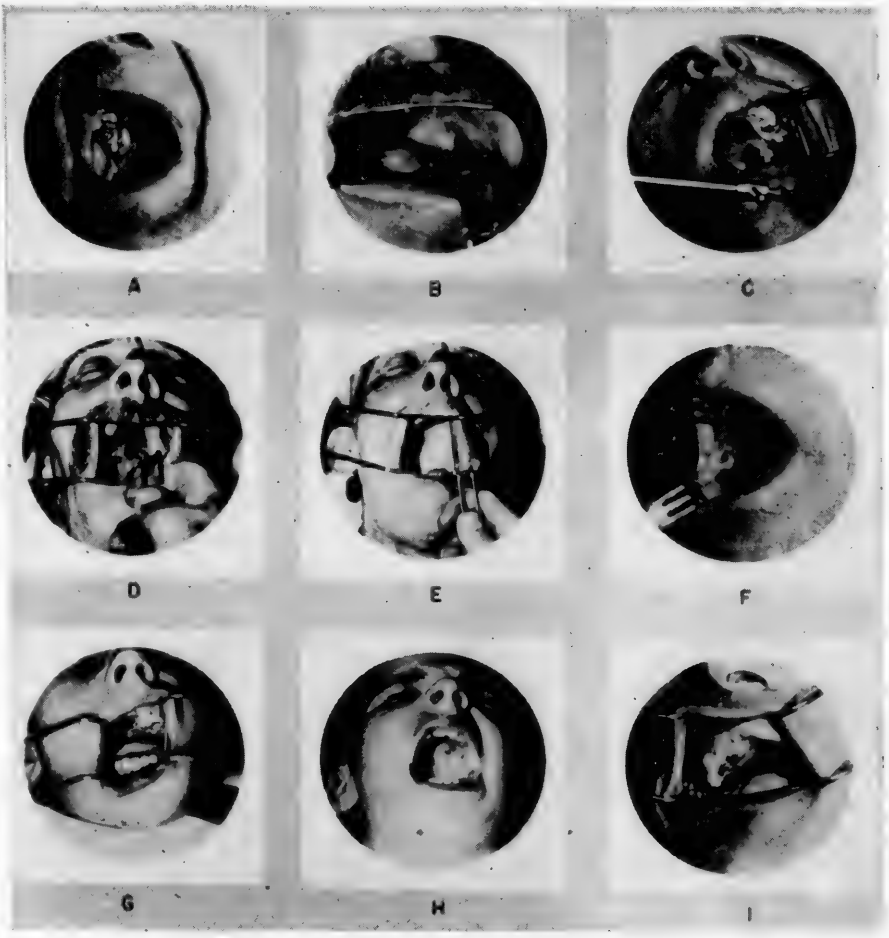

Figure 4. Series of clinical photographs.

Figure 4 is a series of clinical photographs. (A) is an infected area of the upper right molar region, which was easily photographed without the aid of any instruments. This patient was very cooperative and the photograph was easily made. (B) is an x-ray reaction in the posterior pharynx. Here, two instruments were necessary, a mouth gag and a

tongue depressor. This is a good example of the value of using a diaphragm stop of f 45. (C) is a dry socket in an upper left cuspid region and is a case in which a mirror is necessary. The arm supporting the mirror is quite evident and this picture could be improved by placing the arm in another position. (D) is a mucous membrane epithelioma in the soft palate. This picture is shown to illustrate the results of the improper placing of the tongue depressor. The assistant's hand is also too noticeable. If the assistant who held the tongue depressor had grasped it a little lower on its handle, it would have improved this picture. (E) shows the healed lesion on the same patient in which the criticism as stated above has been corrected. (F) is a mucous membrane epithelioma of the inner cheek and the corner of the mouth. In this case the two Volkmann's retractors are very necessary for they are small and yet supply sufficient retraction without covering too much of the inner cheek. (G) and (H) are taken on the same patient, showing the carcinoma on the roof of the mouth of a nine year old boy. (G) shows the result when using two retractors. This youngster's mouth was very tender and we were not able to get as much retraction as we would like. Yet in (H) after the lesion was healed, the youngster was able to open his mouth sufficiently to show this area completely without retraction. This condition is common. On many occasions it is forgotten that the patient is sick and the mouth has been examined by many before they present themselves for photographs. (I) is a large benign tumor of the upper gum. The two retractors give an excellent exposure.

Conclusions

Photographs of the oral cavity are easily made. There are three important factors necessary: instruments to give an operative exposure, film to record the lesion, either black and white, or color, and sufficient light to illuminate the cavity. It must be emphasized however, that the head rest is also important for immobilizing the patient. It is recommended that a flash bulb be used because of the intense light which makes it possible to use small diaphragm stops, thus giving much greater depth of focus. Over 90 per cent of lesions in the mouth can be taken without a special light.

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1. W. F. Payne: Photography of the Oral Cavity, Jour. Bio. Photo. Assn. Vol. 2, No. 2, Page 72, 1933.
2. F. R. Harding: Photography of the Oral Cavity, Jour. Bio. Photo. Assn. Vol. 2, No. 1, Page 25, 1933.
3. Ralph Creer: Photography of the Oral Cavity, Jour. Bio. Photo. Assn. Vol. 4, No. 2, Page 68, 1935.

The Theory and Application of Stereoscopy to Patient Photography

T. M. Graber, D.D.S., M.S.D.

DEMOCRITUS of Abdera, in the third century B.C., taught that all bodies were continually throwing off certain images like themselves, and that these emanations stimulated our bodily organs, giving rise to specialized sensations. These images vary in size, distance and shape under many environmental conditions. Under the action of light, a body makes its superficial aspect potentially present at a certain distance, becoming appreciable as a shadow or picture.

Man learned to evaluate fleeting visual images, and to adjust himself to his environment accordingly, but sensory stimuli are transient in nature, and he had at first only laboriously hand-drawn reproductions for any permanent records. Photography provided a badly needed "missing link" by making the surface of a sheet of paper receive images and hold them as pictures. There is no need to tabulate the multitude of uses to which this invention of a "mirror with a memory" has been put. Its application forms an integral adjunct in every branch of art and science. But there has been one shortcoming. Man evaluates visual images in three dimensions. Pictures provide only two dimensions on a flat surface. This lack of plasticity often inhibits accurate appraisal of the recorded image. Fortunately, the mind has learned to endow these images with depth in most cases, partly through lines of perspective, partly through knowledge of normal relations of objects as they appear to the unaided eye, and partly through a conscious effort to compensate for the lacking third dimension.

The physiologic and optical bases for binocular or stereoscopic vision, and a practical means of applying the phenomenon to man-made likenesses, have puzzled scientists for many centuries. The word "stereoscope" is derived from the Greek "stereo" meaning "solid", and "scopio" meaning "I view".[1] Less literally, we may interpret the word to mean the endowment of plasticity and a third dimension to objects by the

[1] Judge, A. W., *Stereoscopic Photography; Its Application to Science, Industry and Education*, London: 1935, p. 8.

Received for publication November 29, 1946, Northwestern University Dental School.

two eyes. Helmholtz and others have shown that stereoscopic vision gives rise to plasticity because of the difference in the views presented to the two eyes, dependent upon the interpupillary separation.[2] This concept is not new. The fact that pictures of bodies seen by both eyes are formed by the union of two dissimilar pictures was known by ancient mathematicians. Euclid knew it in his 26th, 27th and 28th theorems of his *Treatise on Optics*.[3] Galen substantiated Euclid's work and added:

> But if any person does not understand these demonstrations by means of lines, he will finally give his assent to them when he has made the following experiment:—Standing near a column, and shutting each of the eyes in succession;—when the right eye is shut, some of those parts of the column which were previously seen by the right eye on the right side of the column, will not now be seen by the left eye; and when the left eye is shut, some of those parts which were formerly seen by the left eye on the left side of the column will not now be seen by the right eye.[4]

Since Galen, a number of writers have studied binocular vision. Baptista Dorta, in his work *On Refraction,* believed that we see only with one eye at a time.[5] Da Vinci corroborated the work of earlier investigators and further delineated certain refinements.[6] Aguilonius, who published his works in 1613, accounted for binocular vision by the following:

> The reason, I think, is that the bodies do not appear to be single, because the apparent images, which are formed from each of them in separate eyes, exactly ccalesce (sibi mutuo exacte congruent), but because the common sense imparts its aid equally to each eye, exerting its own power equally in the same manner as the eyes are converged by means of their optical axes. . . .[7]

In 1775, Harris wrote:

> By the parallax, on account of the distance betwixt our eyes, we can distinguish besides the front part of the two sides of a near object not thicker than the said distance, and this gives a visible relievo to such objects, which helps greatly to raise or detach them from the plane in which they lie. Thus the nose on a face is the more remarkably raised by our seeing both sides of it at once.[8]

In 1838, Wheatstone wrote in detail:

> It may be supposed that we see only one point of a field of view distinctly at the same instant, the one, namely, to which the optical axes are directed, while all other points are seen so indistinctly that the mind does not recog-

[2] Helmholtz, H., *Physiological Optics,* (translated by J.P.C. Southall, Optical Society of America), 3:375, 1925.
[3] Euclid, *Treatise on Optics,* Edit. of Pena., pp. 17-18, Paris:1577; *Opera, Gregory,* pp. 619-20, Oxon:1703; quoted in Brewster, Sir David, *Stereoscopic Photography,* London:1856.
[4] Galen, *De Usu Partium Corporis Humani,* Edit. Lugundi:1550, p. 593 quoted in *ibid.*
[5] Dorta, Baptista, Portae Neap, *De Refractione Optices Parte,* 5:132, 6:143-45, Neap.1503.
[6] Da Vinci, Leonardo, *Trattata della Pictura Sculptura ed Architettura,* Milan:1584.
[7] Aguilonius, P., *Opticorum Libri Sex Philosophis juxta ac Mathematicis utiles—Folio.* Book XXXVIII, 2:14-41, Antwerp:1613.
[8] Harris J., *Treatise on Optics,* London:1775, pp. 112, 171.

> nize them to be either single or double, and that the figure is appreciated by successively directing the point of convergence of the optic axes, successively to a sufficient number of its points to enable us to judge accurately of its form. That there is a degree of indistinctness in those parts of the field of view to which the eyes are not immediately directed, and which increases with the distance from that point, cannot be doubted; and it is also true that the objects there obscurely seen are frequently doubled. In ordinary vision, it may be said, this indistinctness and duplicity are not attended to, because the eyes shift from point to point continually, every part of the object is successively rendered distinct, and the perception of the object is not a consequence of a single glance, during which a small part of it only is seen distinctly, but it is formed from a comparison of all the pictures successively seen while the eyes are changing from one point of an object to another.[9]

Thus Wheatstone attributed binocular vision to a combination of two dissimilar pictures in the brain, and believed that the mind coordinated the successive groups of dissimilar pictures into a logical and consistent image in the brain. In 1856, Brewster gave a detailed account of the history of stereoscopic fundamentals and agreed, in essence, with the work of his predecessors. He gave a detailed description of the eye structure, amazingly close to the description in our best sources today.[10]

Holmes thought the impression of solidity was due mostly to the education of the eyes.[11] The basis, of course, is coordination of the two different views seen by the two eyes. The mind feels around the object, according to Holmes.[12] Only certain parts of the retina work together, as shown when one pushes one eye slightly in with a finger, with a double image the result.

Modern physiologic explanations of stereoscopic vision stress the faculties of accommodation and convergence as making stereoscopic vision possible.[13] May says,

> Accommodation is the power of altering the focus of the eye so that the divergent rays (those coming from an object nearer than 20 feet) are brought together on the retina); that is accommodation by means of an increase in the convexity of the lens, and thus in its refractive power. The degree of accommodation must vary for every distance of the object; the eye cannot be adapted for two different distances at the same time. The preceeding considerations of the subject of accommodation refer to mono-

[9] Wheatstone, Charles, "Contributions to the Physiology of Vision", *The Scientific Papers of Sir Charles Wheatstone*, London: 1879, pp. 225-83, (Published by the Physical Society of London).

[10] Brewster, Sir David, *The Stereoscope: Its History, Theory and Construction*, London: 1856 (John Murray).

[11] Holmes, Oliver Wendell, *The Stereoscope and Stereoscopic Photographs*, New York & London: 1903 (Eighth Edition).

[12] *Ibid.*

[13] Martinsen, William, "Stereophotography with Special Reference to Gross Specimens", *Jour. Biol. Photo Assn.*, 8 19-33, Sept., 1939; Maurer, John A., "Stereophotography, Near Objects and Stereoprojection", *Jour. Biol. Photo. Assn.*, 12:13-16, Sept., 1943; Dalzell, J. Moir, *Practical Stereoscopic Photography*, London: 1936; Judge, A.W., *op. cit.*; Kurtz, H., Bridge, E., "A Method of Precision in Stereoscopic Roentgenography", *Amer. Jour. Roentg.*, XVIII, 4:370-77, Oct., 1937.

> cular vision or sight with one eye. With binocular vision it is necessary to consider convergence as well as accommodation. For these two actions (together with the contraction of the pupil) are normally associated. Convergence is the power of directing the visual lines of the two eyes to a near point, and results from the action of the internal recti muscles. When we look at a distant object, accommodation is at rest and visual lines are parallel. When we look at a near object, we are compelled both to accommodate and to converge for that distance; with a certain amount of accommodation a corresponding effort of convergence of the visual line is associated.[14]

Specific interaction between accommodation and convergence is essential for stereoscopic or binocular vision. Perspective is the third condition necessary for stereo-vision.

Helmholtz has held the inter-pupillary separation responsible for dissimilar images being projected on our retina, plasticity being the result of the merging of these images by our mind. The average distance between the pupils is given by most investigators as 65mm (about 2½ inches). Helmholtz found that the least discernible difference between the right eye and left eye views is represented by 60 seconds of arc.[15] Later investigators have shown a number of times that 10 seconds of arc is more nearly a correct value for normally acute vision.[16] Martinsen has found that with an average interpupillary distance of 2½ inches, the subtended angle is about 10° (9°32′).[17] Also, as the distance between the object and observer increases, plasticity or depth decreases. When the retina no longer detects different images, stereoscopic vision ceases and we tell difference by parallax (relative movement of objects.) May thinks the near point recedes with age, from 2-3 inches in early life to 16 inches at 50 years. In Figure 1, "A" and "B" indicate two points in space in front of the eyes at some distance

[14] May, Charles H., *Diseases of the Eye*, Philadelphia:1922, (10th edit.), pp., 310-14.
[15] Helmholtz, H. V., *Handbuch der Physiologischen Optik*, Berlin:1910. (Translated by Optical Society of America, 1925).
[16] Pulfrich, C., *Stereokopisches Sehen und Messen*, Jena:1911; Kurtz, H. F., Bridge, E., *op. cit.*
[17] Martinsen, William, *op. cit.*

Figure 1

Figure 2. Zeiss Stereoscope.

Figure 3. Stereocamera on fixed attachment, matched lenses, fixed focus. Always in the same relation to the patient.

Figure 4. Stereocamera with double extension bellows.

Figure 5. Cutler watercooled lamp for illuminating small areas.

Figure 6. Cephalostat or head fixator. Mobile arms with short ear-rods on precision calibrated slide. A calibrated circular (a) slide permits the lateral and profile views. Pointer establishes horizontal plane and an adjustable rubber head rest. (b) Diagram showing positioning of patient and relation of stereocamera to cephalostat.

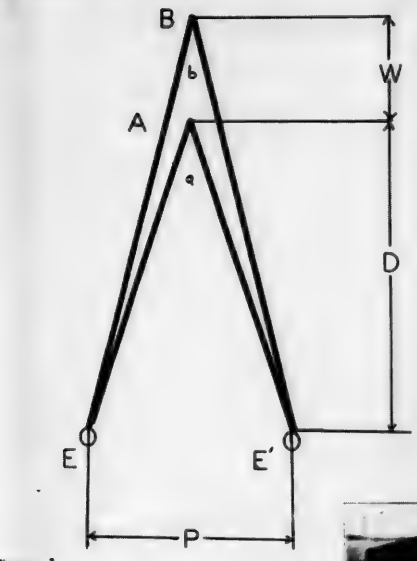


Figure 1

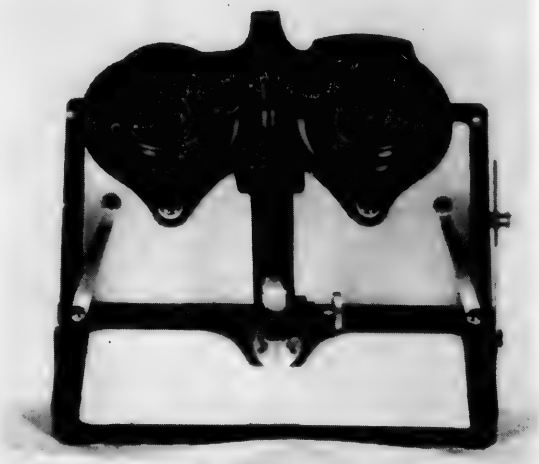


Figure 2

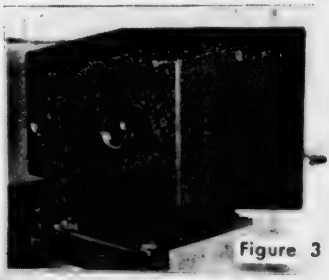


Figure 3

Figure 5

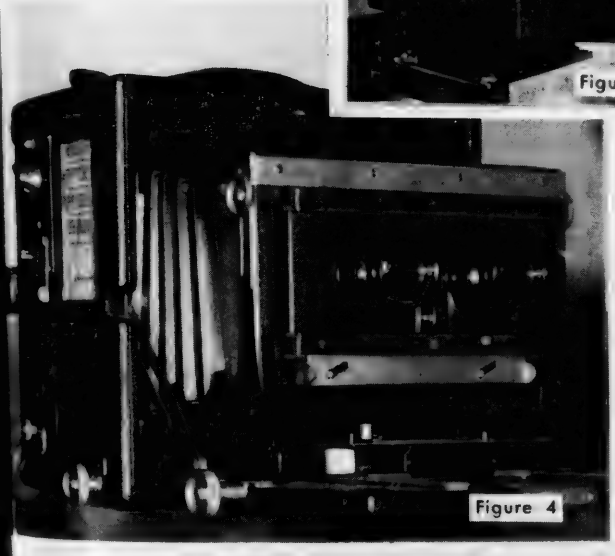
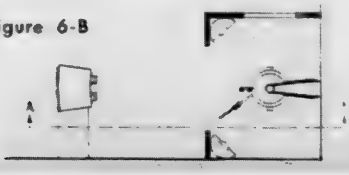


Figure 4

Figure 6-B



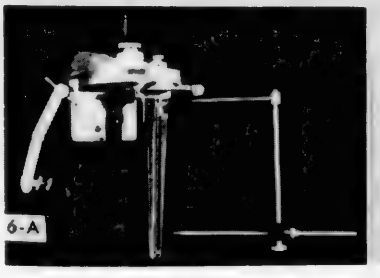


Figure 6-A

"d", just slightly longer than the shortest distance of comfortable accommodation. The two points are separated by a distance "w", in the direction of observation. Two eyes are indicated at E and E', separated by the interpupillary distance "p", 65mm. The near point "A" subtends the angle "a", the far point "B", the angle "b". Helmholtz showed that the separation "w" can be perceived only when the differences between the two angular subtenses, "a" minus "b", is greater than some small limiting angle. Helmholtz found this minimum or limiting angle to be 60 seconds of arc. Though this figure was later reduced to an average of about 30 seconds of arc, the reasoning is the same. If the limiting angle cannot be satisfied, plasticity disappears. At 30 seconds, this would be 1467 feet, (¼ mile).[18] The distance at which the third dimension is perceivable is controversial in nature. Dalzell, by contrast, believes that true stereoscopic vision is non-existent beyond 18-22 yards, or 250-300 times the interpupillary distance. He states that the object-retina distance should be at least 50 times the interpupillary distance for true, undistorted depth perception.[19] At any rate, intervening haze, color alteration, lights and shadows, and intermediate objects enhance the impression of depth. Holmes called it "the education of the eyes."[20]

The above principles apply to the unaided eye. Interposition of any optical system cannot change the characteristics of the eyes. But it is possible by means of optical instruments to utilize the optical physiologic phenomena and endow certain images with plasticity or depth. Instead of transient images that stimulate the retina in normal vision, "arrested images" or photographs can be used. Views that satisfy the necessary conditions to produce correct "depth relations" are called orthostereoscopic views. By reproducing "arrested images" that stimulate normal retinal views for each eye, the illusion of depth is produced, even though these photographs are in the same plane.

An optical instrument must satisfy the optical requirements for binocular vision. Minimum normal viewing distance is about 15 inches, and the camera must be placed in normal viewing distance from the object with normal interpupillary separation of the camera lenses—65mm. Selective observation is important, too. The left eye must see only the left picture, the right eye only the right picture. Sufficient differences in the images must exist to satisfy the minimum angle subtense of 30 seconds arc of front and back limits of the object. It is vitally important that the viewing system lenses have the same focal length as the photographic lenses to prevent distortion. If the lenses

[18] Kurtz, Henry F., "Orthostereoscopy", *Jour. Optical Soc. Amer.*, 27:323-339, Oct., 1937.
[19] Dalzell, J. Moir, *op. cit.*
[20] Holmes, O. W., *op. cit.*

are too far apart, the photographic images will appear smaller and farther away, if too close together, they will appear magnified and too close. As with the camera lenses, the distance between the nodal points should approximate interpupillary distances.

The stereoscopes or stereo viewers are of several types. Wheatstone, in 1838, designed the first practical optical stereoscope which he stated was merely a substitute for the muscular power which brings the two pictures together. The reflecting stereoscope of Wheatstone consisted of two 4 inch square plane mirrors forming a 90° angle with each other, plus accessory paraphernalia.[21] Brewster developed the prismatic type of viewer shortly afterwards, and by cutting lenses in sections was able to construct a lenticular stereoscope in 1856.[22] The old style handle type, designed by Oliver Wendell Holmes is still in use. Holmes used segmented lenses. By cutting a convex lens through the middle, grinding the curves of the two halves down to straight lines and joining them by their thin edges, a "squintmagnifier" or stereoscope was produced. This type causes distortion, even with the prints mounted as they should be—with their optical centers equal to the interpupillary distance.

Modern viewers, such as the Zeiss Verant, figure 2, are descendants of these early crude instruments, but with large aperture, whole, well corrected, short focus lenses.

Size and types of cameras. Stereophotography can be accomplished by a number of types of photographic equipment. A simple box camera can be used in a limited selection or subjects by snapping the subject, moving the camera about 2½ inches and taking another view. Thus any single lens camera can be used. Several techniques and modifications have been introduced using single lens cameras. A wood sliding base is the simplest and most practical method advanced.[23] An alternative is moving the object a trifle and making another picture, but this is not accurate and cannot be used on live subjects. Two well standardized cameras of exact construction can be placed or bound together, lens settings equalized, and both shutters snapped simultaneously. The best arrangement is a single camera with two lenses. Judge lists the essentials of a stereocamera as (1) rigidity, (2) good lenses, (3) convenient focusing, (4) good shutter or shutters, (5) lateral and vertical movement, (6) convenient film or plate holders, (7) weatherproofedness, (8) compactness, (9) efficient and convenient view finder, (10) provision for attachment of accessories.[24]

[21] Wheatstone, Charles, *op. cit.*
[22] Brewster, David., *op. cit.*
[23] Martinsen, William, *op. cit.*
[24] Judge, A. W., *op. cit.*

There is a wide choice of cameras—5x7 inch Speed Graphic, Graflex, Bausch & Lomb, 4x5 inch Recomar, Zeiss or specially constructed cameras such as the twin reflex type of Weingart and Sage and the fixed-focus twin lens type of Margolis,[25] figure III. The 5x7 inch size is the most popular, although 3¼x4¼ inch is finding increased use. Either a ground glass focusing screen or reflex type camera is imperative for good results.

The Folmer-Schwing Graflex camera of Eastman is quite similar to the Speed Graphic camera, with double extension bellows, ground glass focusing screen, 5x7 inch plate and film holders, focal plane shutter, etc. There is an adjustment for varying the nodal point distances of the twin matched lenses. Weingart and Sage designed a stereocamera for Bausch and Lomb which also permitted accurate bellows focusing, lateral movement of lenses, and taking views within 9 inches. The lens board has vertical and horizontal adjustments and an extension bed. It is equipped with a focal plane shutter of the same speed as the Folmer-Schwing model, 1/10th to 1/1000 second.[26] Harding finds that a fixed focus camera works very well. His camera has a fine adjustment, and can be used either horizontally or vertically. It is fitted with a double slide carrying a frame holding either ground glass or 5x7 inch film and a plate holder. Means are provided to adjust for the various magnifications desired, shifting the plate and also transposing the views between exposures. A photographic shutter is mounted at the bottom of the camera chamber (when mounted vertically), which may be adjusted for time release, and instantaneous exposure of varying duration. Various objectives may be introduced into a dove-tailed clamp provided for them.[27]

In 1935, Leica introduced the Stereoly attachment for 35mm cameras. This is a two prism arrangement, set 70mm apart (approximately interpupillary distance), which directs two images into the single lens of the camera and forms a two image exposure on the single frame. Each picture is 18x24mm.[28]

Lens type and aperture. The consensus of opinion requires a fairly long focus lens for this type camera, for maximum image fidelity and minimum perspective distortion. The photo objective should be an anastigmat which provides an aplanatic field, without stopping down the diaphragm as required in a portrait lens. Depth of focus is quite

[25] Margolis, Herbert, "Technique for Recording Dental Changes and Facial Growth", *Amer. Jour. Orth. & Oral Surg.*, 25:1027-39, Nov., 1939.
[26] Weingart, J. S., Sage, R. A., "Stereoscopic Photography of Pathological Specimens", *Archives. Path.*, 19:685, May, 1935.
[27] Harding, F. R., "The New Orthostereocamera and Orthostereoscope", *Jour. Biol. Photo. Assn.*, 4:168-9, 1936.
[28] Lester, Henry M., "Stereoscopic Photography", *The Leica Manual*, pp. 249-55, 1935.

important in stereophotography; so a fast lens with its limited depth is neither necessary nor desired. It is best to stop the lens down to at least F6.3, but not more than F9. While too large an aperture causes too little depth, too small an aperture causes vignetting of the image and puts a strain on the demands of illumination. Harding notes that F8 is the largest aperture conferring sufficient depth of field.[29] Weingart and Sage use matched Bausch and Lomb Protars with an aperture of F6.3.[30]

Using two matched lenses, the stereocamera poses a problem peculiar to stereophotography—the separation of the lenses. Varying the distance between the lenses directly affects the viewed image. Bolton points out that increasing the distance between the lenses of the camera may give a more decided impression of depth. Actually, the subject appears nearer but smaller.[31] Maurer also notes that the apparent scale of the stereoview will vary with changes of the inter-lens distance.[32] Judge stresses the fact that the nearer the subject is to the camera, the smaller the separation needed to satisfy the Helmholtz theory.

Lighting, film and exposure.— Stereophotography demands careful attention to the lighting problems. Flat, shadowless lighting, so necessary for color photography, is worthless for stereophotography. Harding prefers clear glass 1000 watt lamps because they produce harder shadows and bring out more contrast and modelling than softer light from frosted lamps. He sets his lights about 3½ feet from the patient—and this distance is maintained for standard exposures. The light should usually fall down on the patient, though there are exceptions to this rule. This prevents flat lighting and enhances modelling. For normal lighting, one light may be placed 12 inches farther away than the other. Pockets of shadows about the neck and under the chin should be avoided. Slight shadows seen by the eye are increased in contrast by the photographic emulsion. To model the top of the head, there should always be a permanent light of about 500 watts affixed to the top of the background. For head pictures, lights are placed 1 foot on each side of the camera, level with the top of the patient's head.[33]

There is considerable difference of opinion on some of the lighting details. Haggett recommends a tracing cloth or silk glass screen in front of the flood lights to improve diffusion and modelling.[34] Judge

[29] Harding, F. R., "Application of Clinical Photography to Private Practice", *Jour. Biol. Photo. Assn.*, 8:132-34, 1940.
[30] Weingart, J. S., Sage, R. A., *op. cit.*
[31] Bolton, L., "Stereoscopic Distortion", *Photo. Jour.*, 4:107-18, 1903.
[32] Maurer, John A., "Stereophotography, Near Objects and Stereoprojection", *Jour. Biol. Photo. Assn.*, 12:13-16, Sept., 1943.
[33] Harding, F. R., "The Lighting and Posing of Clinical Photographs", *Jour. Biol. Photo. Assn.*, 6:131-35, Dec., 1937.
[34] Haggett, Martin, "Clinical Photography for Orthodontists", *Amer. Jour. Orth. & Oral Surg.*, 25:1085-87, 1939.

thinks that if the object is illuminated from one side, there is a pronounced gradation of tones, which helps produce an effect of solidity or depth. If the object is illuminated from both sides, there is a loss of apparent solidity. Shadows and half tones considerably enhance stereoscopic vision.[35] Little use is made of the photo flash because of flat lighting. Haggett recommends it only for small children. At times, the operator demands a narrow beam of light for a highly localized field, such as stereophotography of the oral cavity or eye. Hughes found that a carbon arc lamp, controlled by an iris type shutter, gave most uniform illumination.[36] Creer suggests the Cutler watercooled lamp for intra-oral views, figure V.

Film for stereophotography must be fine grained because of the magnification in the stereoscope. Orthochromatic film does not give the soft shadow gradations necessary. A fairly fast panchromatic film is the one of choice. Color film has been used. Beck utilized the Lumiere process in 1912 to give amazingly lifelike stereophotographs which looked like colored plaster of Paris casts.[37]. The coarse granular effect of the color process was a serious drawback at that time, but Kodachrome has eliminated this object. Especially effective and brilliant are Kodachrome transparencies, either projected or viewed through a small magnifying viewer.[38]

The exposure factor parallels the demands of any portrait technique. Maximum speed, consistent with a well stopped down lens, adequate depth of field, illumination and emulsion speed of the film is desirable where patient movement is a constant prospect. Since a moderately fast panchromatic film is most popular, exposures are usually fairly short. Figures range from 1/10 to 1/50th second. Exposures longer than 1/10th second invite failure.

Positioning the patient. As Brewster notes, the position of the patient is important. He writes:

> First we must select the best aspects of the face, and what is of more importance than is generally supposed, to determine the best distance from the camera at which he should be placed. At a short distance, certain parts of one's face or figure which should be seen are concealed. Prominent features become less prominent by distance.[39]

Judge supplements this by admonishing that soft effects and well graded half tones aid the stereo effect and thus a three quarter face is more effective than a full face—as far as a portrait is concerned.

[35] Judge, A. W., *op. cit.*
[36] Hughes, W. L., "Stereoscopic Photography", *Arch. Ophth.*, 3:583-87, May, 1930.
[37] Beck, E. G., "Stereoscopic Photography with Natural Colors", *Surg., Gynec. & Obstetrics*, 14:425, 1912.
[38] Harrington, R. H., "Stereophotography comes to Life", *Leica Photography*, 6:7, 18, 1937.
[39] Brewster, Sir David, *op. cit.*

In some fields, such as Orthodontics, a rigidly posed and oriented photograph may be desirable. Margolis has adapted the "rigid orientation" motif to stereo work. Patients are positioned by a modified craniostat which he calls a cephalostat, figure VI. An adjustable rubber head rest is attached to the posterior part of the cephalostat and in the same plane as the ear rods, an arm and pointer are placed anteriorly to locate the inferior border of the orbit, so that the head may be set in "Frankfort Plane".[40]

Whether the technique demands a strict orientation or merely a natural sitting pose, it is important that the two images are approximately equidistant from the midline of the ground glass plate, and it is equally important that enough of the features show to supply the detail wanted.

Background. With a stereotechnique, it is important to have a very obscure background. The general agreement is for a dark background. Haggett recommends a dull gray for patients, as does Judge. This gives a good contrasting relief effect. For photographing casts or pathological specimens, black is best suited as a contrast medium.

Summary. Stereophotography offers a practical method of photographic appraisal of patient clinical material. Its inherent advantage conferred by a physiologic impression of solidity derived from paired pictures in the same plane should make the observer more keenly appreciative of discrepancies not discernible in conventional photographs.

[40] Margolis, Herbert, *op. cit.*

Book Reviews

Photographic Abstracts, 1946, part 4, Abstracts 1096-1455P. The Scientific and Technical Group of The Royal Photographic Society of Great Britain. Editors V. Gallafent, M.Sc., D.I.C., F.C.I.P.A., F.R.P.S. and H. G. Suggate, B.Sc., A.R.P.S.

"Photographic Abstracts" was founded in 1921 by the Scientific and Technical Group of the Royal Photographic Society to provide a regular single source of information on all aspects of scientific and technical photography. Relevant papers are abstracted from all the important British and foreign journals and there is a substantially complete cover of British and American patents relating to photography.

In an average year the "Abstracts", which are published quarterly, amount to 1200 to 1500 items. The abstracts are classified on the Universal Decimal Classification, to which a guide is published at the beginning of each year, and subject cross-headings are provided to facilitate reference. Annual Author and Patent Number indexes are provided and also decennial subject matter indexes the first of which, 1921-1930 is in print and the second of which, 1931-1940 is in course of preparation.

The subscription, despite the very considerable increase in printing costs, remains at 30/-per annum, post free, or 32/6d. per annum, post free, for copies printed on one side of the paper only.

"Medical Research", a Symposium, Edited by Austin Smith, M.D. J. B. Lippincott Company.

This book provides the answers to "what is medical research, who contributes, what does the contributor expect in return, how is research money used, and what are the needs that exist and what methods can be used to meet these needs?" All phases of research are discussed by experienced key men in the field. Fundamental procedures together with newer advances are all considered. Photography is one of these newer approaches. An excellent chapter is devoted to it, illustrated in black and white and color. This book should serve as a stimulus for further thought and should afford appreciation of the need for continuous medical progress.

"Photography by Infrared" by Walter Clark, Second Edition, John Wiley and Sons Inc. London: Chapman and Hall, Limited.

This book is a revised authoritative source on infrared photography, covering the underlying principles, practises and applications in the field of science and technology. This second edition has many additions which supply recent information on camouflage detection, criminology, focus of lenses, characteristics of paints and pigments, medical infrared photography, applications in botany, infrared photomicrography, aerial photography and other developments. Bibliographies have been brought up to date. Here we can find information and references on any point of special interest in the field of infrared photography. The excellent format enhances the appearance of the book. "Photography by Infrared" should be in every photographer's library.

Photo-Lab-Index. The Cumulative Formularly of Standard Recommended Photographic Procedures. Henry M. Lester. Published by Morgan and Lester, New York 17, N.Y. 8th edition, 1946. Price, $8.

Since Photo-Lab-Index first appeared in 1939 new sections have been added and others greatly enlarged. This edition is in the form of a permanent cloth-bound volume. It is of wide scope, divided into twenty-three sections and contains about 600 pages. Titles of the first eleven sections are stamped on the front cover, the remaining twelve on the rear cover. The marginal finger tabs provide easy reference to the wealth of data in tabulated form concerning photographic materials, formulae, processes, apparatus and methods. There are about 3,000 bibliographic references and a glossary of photographic terms.

It is difficult in this brief review to do justice to the completeness and usefulness of this invaluable aid to the photographer. It should be in every photographic library.

Editor.

"Let's Make A Movie"

Mervin W. La Rue and Richard W. Kleidon

LET'S make a movie. All too often that statement alone represents the total amount of thought and planning expended on the project prior to the actual "shooting of pictures."

Making a movie is a simple matter as any amateur photographer will tell you. All you need is a camera, some film and a few lamps. Then you just "push the button", and the fairies do the rest.

First, we must have a camera, so perhaps we can borrow one. If it has a lens so much the better. We will need some film, of course, but perhaps a friend can get it for us wholesale. With a few photofloods in various types of reflectors clamped on miscellaneous stands or pieces of furniture, we are well under way.

Writing a script is a lot of work, so why bother? We will probably want to change it anyway.

Anxious to get started, we find that many interesting cases present themselves almost immediately—so "a shooting we must go." We simply *must* get some of these cases while they are available. We don't know at the moment just how they will fit into our thesis, but we are certain we can work them in somewhere.

Making notes for identification of scenes is quite a job, and as we are certain we will be able to identify them anyway we dispense with this formality. Later, we may wish we had more information regarding these cases, but we will worry about that—later.

And later, along about the middle of the project, we are haunted by a vague sort of feeling that perhaps we should take "time out" and sort of review the subject—ascertain what scenes we have—and what scenes we should have to complete the project.

It is about this time that most of us start to think of writing a script —and wish we had done so at the beginning. We find that we do not have as much material as we thought we had—that much of it is not quite suitable—that we could have done much better—and that we have considerable footage that we could very well do without.

Accordingly, we prepare a list of scenes needed to complete the film and in the meantime spend considerable time editing and arranging the material already available.

Received for publication September 27, 1946 from Medical Motion Pictures and Illustration, 159 East Chicago Ave., Chicago 11, Ill.

Of course, we will need titles, or captions, and on investigation learn there are many ways of making these, each more expensive than the last. We consider the possibility of making our own from typewritten sheets or hand lettered cards, but finally decide to have them made for us. Since cost is an important factor we select the least expensive method, believing it adequate for our purpose. It should work out okay just as long as they can be read on the screen.

By this time, we are rather tired of the whole thing and anxious to see our project completed. So, we hurriedly splice the titles into place just in time to show our film at an important meeting. There is no time to have a duplicate made, so we use the original and after the meeting we put it away and forget it until the next time we want to show it. Somehow, we never do get the time to have a duplicate made until later we notice that our original is becoming marked with oil and scratched. By this time it is much too late to do anything about it.

What is wrong with that picture? Well, just about everything.

Any worthwhile project warrants careful thought and planning. Especially is this true of any subject designed as a visual aid to teaching. We hear a great deal today about visual education. This so-called "Visual-Education" has been extensively praised in some quarters but just as strenuously damned in others. The truth—as usual—lies somewhere between.

You have all heard the pat statement of sales managers and executives engaged in modern merchandising—"A real salesman can sell artificial ice to an Eskimo." In reality, a trained and practical salesman wouldn't even think of trying it—for a simple survey of his market would indicate greater sales possibilities nearer home.

Accordingly, a simple survey should always precede the planning of any visual project. This is a simple matter involving no greater thought and effort than plain common sense.

To simplify our subject, and make it easily understandable to all of you, suppose we follow our own formulae—take our own medicine—and briefly survey the *fundamentals* of our subject.

As you all know, we learn by hearing—by seeing—*by thinking*—and by doing. In the process of learning, we do not necessarily apply these in any well established pattern or sequence—but rather concurrently —repeating all or part of them as often as may be desired or necessary.

We may listen without thinking—see without thinking—and, of course, we all occasionally act without thinking.

In the classroom, drawing room, over the radio or luncheon table, we may listen to the speaker while our minds subconsciously gather and project a series of impressions, or pictures relating to the subject in pro-

portion to the amount of concentration, or attention given the subject, or speaker at the time—nature's own way of aiding us in retaining information and impressions.

We may spend hours, or even days in concentrated mental effort to solve a specific problem—but the problem is still unsolved until we apply and test that solution. We may see an act of skill performed while listening to an accompanying verbal explanation of the process involved, yet be unable to perform that act ourselves without repeated trial and error.

Visual aids to learning should be designed to assist and direct our thinking—to make the subject more easily and quickly understood.

Controlled experiments have been conducted in our grammar and high schools for many years and methods evaluated. Briefly, and in order of their importance, are the following:

1. Lecture alone—where results varied tremendously depending upon the skill and ability of the teacher to hold the interest of the students and stimulate their thinking.
2. Lecture accompanied by demonstration—produced improved memory retention as a result of increased interest and attention of students. Results again varied depending upon experience and skill of the teacher.
3. When the lecture and demonstration was supplemented with carefully prepared texts, prescribed reading, false-true quiz, etc., it was found that students mastered the subject of the text more effectively and in less time.
4. When in addition to the above, students were given an opportunity of performing the demonstration themselves and taking an active part in class room activities, learning was further accelerated. Especially is this true in our technical schools where the art of "learning by doing" under proper guidance has been developed to an astonishing degree.

Briefly then—by hearing, seeing, thinking and doing—we can become proficient, and in turn demonstrate to others. There is no way of learning except by mental and physical effort—so we see there is no such thing as "Visual Education." The phrase is vague and misleading, for we are in reality dealing with only one *phase* of the learning process—*"Visual Aids to Learning"*.

There are many varied kinds and types of Visual Aids ranging from simple blackboard demonstrations to elaborate and expensive motion picture production. Nevertheless, they are all just that—*"AIDS"* to

learning. Unless they are intelligently conceived, planned, produced and properly applied, they cannot produce the results we have every reason to expect.

Some of these *aids* to learning are text book illustrations, laboratory demonstrations, charts, graphs, models, exhibits, lantern slides, slide films, and motion pictures. You are familiar with all of them.

As we are primarily interested in the motion picture, our discussion will be confined to this medium.

Accent on Purpose

The motion picture is a most excellent and practical medium of accomplishing many purposes, but if satisfactory returns are to be realized, certain definite procedures must be employed. There is "one best way" of accomplishing any task, and 30 years' experience in the making of films with a purpose has convinced the writer that the following recommendations are fundamental and essential.

FIRST: Every motion picture must have a definite purpose and must be prepared to accomplish that purpose only.

SECOND: All details relative to planning, preparation, production and application must be carefully worked out in advance.

THIRD: Plan the work and work the plan.

Let us take these in order.

1. The purpose of a teaching film and the selection of the subject go hand in hand. If mental effort is required in the selection of a subject, then in all probability the subject is not one of urgency. The purpose determines the subject and the subject the purpose.

   The subject and purpose determined we must next make certain that the motion picture is the best medium of accomplishing that purpose. Will it make a good movie? Can we tell the story in pictures—motion pictures? Remember we are dealing with a medium whose principle advantages are the recording and portrayal of action, time and motion.

A prolonged scientific study may present dramatic findings in terms of facts, figures and percentages, but a scientific or clinical report of such findings will certainly not make a good movie. Nevertheless, the subject can no doubt be presented most effectively with the aid of pictorial charts, graphs, lantern slides or slide film at a considerable saving in cost. Subjects that are static can usually be done better in another way.

On the contrary, however, a subject demonstrating precise technic, procedures or methods can usually be handled most effectively in motion pictures.

2. All details of the entire motion picture program must be worked out in advance. This is just good common sense and results in a much better job and far better results at less cost.

   A careful analysis must be made to determine all the possibilities surrounding the visual presentation of any subject. This is most important, and an excellent approach is to first ask ourselves, "Can we tell at least 80 per cent of our story in pictures—and will most of our pictures be in motion?"

   If the answer is "yes", then we are reasonably certain that our subject can be well presented in motion pictures, and if carefully planned and prepared will serve a worthwhile purpose.

Again, in preparation of our script or scenario we must be careful to avoid all detours, and in an orderly manner and sequence plan our production so as to reach our objective in a direct line. All material not pertaining to the objective can best be forgotten, and much of the material hard to visualize such as history, etiology, etc. requiring "words" to explain can be eliminated. We must reverse the *usual* and *easy* procedure of telling our story in words and illustrating it with pictures, so as to *"'tell' our story in pictures and illustrate it with words."*

In building a house, in planning a vacation, or before embarking on any such project we fully expect to work out all the details in advance. This is much more important in the planning of a teaching film. The ground work, such as gathering data and information, outlining our subject and organizing our material is necessary before proceeding with our blue print—the scenario. The work of planning, production and application can be briefly covered, as follows:

1. Research and gathering of facts.
2. Preparation of outline of our subject with special reference to those factors we can visualize.
3. Preparing a detailed working script or scenario.
4. Making layouts of art work or animated portions, production break down with instructions for those who are to engage in the work.
5. Direct, or cooperate with the producer in the filming, editing, etc.
6. Planning the application of the completed film.

We will endeavor to elaborate on some of the essentials.

Preparation of Script

Having determined the purpose of our film, having made a thorough analysis of our subject, having gathered all available material relative

thereto, and having organized this material in an orderly sequence, we are then ready to start our detailed working script or scenario.

In planning our script it is also well to consider the details of its application, but to avoid confusion we will cover this later in our presentation—after the film is completed.

Again we wish to emphasize the importance of thinking in terms of pictures, and especially pictures in motion.

If we are planning a sound film, the technic to be followed is somewhat different from that employed in the preparation of a silent film. While many of you are already familiar with the silent film, consisting of scenes and titles or captions, we will nevertheless discuss this first—from the producers' point of view.

In the preparation of any scenario the producer is frankly concerned with the technical problems surrounding the actual making of the picture. He takes this into consideration from the very beginning, and while preparing the script gives due consideration to the problems involved in carrying out the production in a practical and economical manner. Figure 1 illustrates the format of a working script—a scenario planned for a silent movie, so suppose we comment upon this as we go.

While there are many forms used, we have found it more convenient and practical to use the same form for both silent and sound films. We have used the standard approved form in the preparation of our pattern.

You will note that all captions or titles are kept to the right while scenes and production notes are on the left. This is done with a definite purpose in mind, for when completed and finally okayed for production, the same copies can serve as instructions for the camera man, the artist, the printer who sets the type, and in fact all personnel who will handle any part of the work. This makes unnecessary the re-writing of special instructions for each with the possibility of typographical and other errors being introduced.

You will note that we have selected a title which is short, quickly and easily understood, and which lends itself well to an artistic layout when presented on the screen.

Following our head title you will note that we "dissolve" into our credit caption wherein we name the authors, and following this frankly acknowledge the assistance of other persons or institutions cooperating.

If you examine a text book you are first interested in the title, and next you naturally want to know who wrote the book. You are further interested in the author's connections and in ascertaining if he is an authority on the subject. We endeavor to follow the same procedure in the preparation of a teaching film.

Having disposed of our head title and authorship and frankly ac-

"Let's Make a Movie"

Kevin W. LaRue
TECHNICAL MOTION PICTURES

Recording Copy.

TITLE "Technic of Continuous Caudal Analgesia" REEL NO. 1 PAGE NO. 2

SCENE	FT.	SEC.	NARRATION
Scene 2. Close up sacral area - skeleton.	35	58	It is somewhat more difficult than lumbar puncture, but with proper instruction, under guidance of one already experienced, the operator quickly acquires skill in the administration of Continuous Caudal Analgesia.
Scene 3. Continue demonstration on sacral area of skeleton.	45	1.15	Proper introduction of the needle is most important and depends on the ability of the operator to locate the sacral hiatus.
Scene 4. Close up sacrum only.	51	1.24	Here we see a fairly normal sacrum and the hiatus - which is the inferior opening of the sacral canal - a continuation of the peridural space.
	57	1.35	On either side of the opening lie the sacral cornu, two small bony prominences, which are usually palpable.
Scene 5. Close up - operator demonstrates with closed fist.	62	1.44	They give a sensation similar to palpation of the metacarpal heads in the closed fist, as demonstrated by Lundy.
	68	1.53	The hiatus is usually found about one half inch superior to the sacrococcygeal junction.
Scene 6. Back to whole skeleton - sacral area only - operator demonstrates	74	2.03	The tip of the coccyx is palpated with the middle finger while the thumb locates the indention marking the hiatus.
	82	2.17	When this indentation has been found, the thumb is replaced by the middle finger. This finger - just

Figure 1. Format of a working script.

knowledged the assistance or cooperation secured, we fade out and into an introductory title, designed to define and introduce the subject matter in as precise and limited terms as possible.

From here you will note that we have only inserted captions where it becomes necessary to clarify some particular point that could not be made clear visually.

Timing is an important factor in the preparation and production of films. The action must proceed in an orderly manner, it must not drag, and yet we must always be sure that we allow sufficient time for the average person in our audience to grasp our meaning. Most films, as produced in the medical field are in color, and are made and released as 16 mm duplicates or prints.

There are 40 frames, or pictures to each foot of 16 mm film, and if the finished film is projected at normal silent speed of 16 pictures per second, a reel of 400 feet would have a screening time of about 16 minutes. From a practical standpoint, however, we find that most of the silent films being used at conventions, exhibits, state and county medical societies and hospital groups are usually projected at a faster rate, or about 20 frames per second with a screening time of 12 to 14 minutes. Because of this tendency, it is best that we base our timing on the faster speed, otherwise there is a possibility that some of our audience will miss or overlook some important point in our presentation.

Sound Films

In the preparation of a scenario for a sound picture we have further problems to contend with. Sound films are always projected at a uniform speed of 24 frames per second. This is 1½ times faster than the speed of a silent film. All sound projectors operate at this constant speed, so that the sound counterpart is clear, distinct, audible and of constant pitch.

Knowing this we can plan our timing precisely—in fact, we must do this if picture action and sound narration are to keep in step. Think of this in terms of music where the score for each instrument is written separately but so timed that all members of the orchestra play in unison and all finish at the same time. Figure 2 illustrates the format of a sound script. This is worth careful study.

Starting at zero, the footage of scenes and running time is indicated on an accumulative basis. Narrative and scene length are carefully matched and timed, and the time marks serve as cue marks making the recording of the narrative much easier.

Figure 3 pictures a standard chart carefully designed to give us the essential facts needed in the preparation of narration to match the length of scenes. A brief examination will show you how to determine the running time of any number of feet of film and the word allowance for the narration assuming a rapid delivery of non-technical copy. We have found this is too fast for medical pictures, so we base our timing on an average of three to 3½ words per foot.

It is essential that we do not exceed 390 feet (screening time of 10:50) in any one reel. Recording film and duplicating film comes in

400 and 800 foot rolls. It takes about five feet to thread a recorder, or printer, and it is unwise to run too close to the end, for some footage must be taken to splice the film to its neighbor roll in processing. A length of 390 feet is, therefore, maintained as a standard. It is, of course, possible to record several reels, or parts of reels, separately and then splice them together in one complete whole.

Marvin W. LaRue
TECHNICAL MOTION PICTURES

TITLE "Continuous Caudal Analgesia." REEL NO. 1 PAGE NO. 2

SCENE	FT.	SEC.	NARRATION
Dissolve to 2. Close up De Lee's "Principles and Practices of Obstetrics" and quote --- Fade in		6	"Why put the whole body under anesthesia when you
Fade out			are going to operate on one part?"
3. Back to book and fade into sub title ---		7	When carried out with skill, continuous caudal analgesia is an extremely safe procedure.
4. Follow through our first case with no captions up to delivery of baby - and cut in:		8	Primipara, 7 pound boy. Contracted outlet made forceps necessary.
5. Back to continue case - and --			
6. First scene of animation - cross section female abdomen - tissue dissolves away showing position fetus - this fades away leaving spinal process -			
Fade in caption --		9	Caudal analgesia is a form of regional anesthesia in which insensibility to pain is produced by injection of a local anesthetic drug into the
Fade out			sacral canal through the sacral hiatus.
7. Dissolve back to close up cross section of caudal area - in animation - needle enters - 45° angle - and scene -- dissolves into very close up caudal area as needle enters and injects solution - flash caption and ---		10	Sacral canal
8. --- as solution goes up to top of frame scene dissolves into upper portion to show continuation - flash in caption ---		11	Closure of dura
--- and follow immediately with caption.		12	End of spinal cord

Figure 2. Format of a sound script.

Geo. W. Colburn Laboratory
16MM SOUND TABLES

WORD ALLOWANCE:
4 words per foot at normal tempo and if copy is non-technical.
Footage should be allowed for separating paragraphs or main divisions of subject matter.

RECORDING & PROJECTION SPEED:
24 frames per second.
1-390 ft. reel in 10:50 min.
1 ft. = 40 frames = 1.7 sec.

THE TABLE ON THE LEFT may be used to match the number of words to the individual scene lengths.

THE TABLE ON THE RIGHT may be used to determine the exact time involved in any given footage. Place your finger on the footage; read at the top for minutes; and to the left for seconds.

WORD ALLOWANCE		TIME CHART IN MINUTES & SECONDS FOR ONE REEL AT SOUND SPEED											
		MIN.	0	1	2	3	4	5	6	7	8	9	10
FEET	WORDS	SEC.	FT.	FT.	FT.	FT.	FT.	FT.	FT.	FT.	FT.	FT.	FT.
		1.7	1	37	73	109	145	181	217	253	289	325	361
3	12	3.3	2	38	74	110	146	182	218	254	290	326	362
4	16	5	3	39	75	111	147	183	219	255	291	327	363
5	20	6.7	4	40	76	112	148	184	220	256	292	328	364
		8.3	5	41	77	113	149	185	221	257	293	329	365
6	24												
7	28	10	6	42	78	114	150	186	222	258	294	330	366
8	32	11.7	7	43	79	115	151	187	223	259	295	331	367
9	36	13.3	8	44	80	116	152	188	224	260	296	332	368
10	40	15	9	45	81	117	153	189	225	261	297	333	369
		16.7	10	46	82	118	154	190	226	262	298	334	370
11	44												
12	48	18.3	11	47	83	119	155	191	227	263	299	335	371
13	52	20	12	48	84	120	156	192	228	264	300	336	372
14	56	21.7	13	49	85	121	157	193	229	265	301	337	373
15	60	23.3	14	50	86	122	158	194	230	266	302	338	374
		25	15	51	87	123	159	195	231	267	303	339	375
16	64												
17	68	26.7	16	52	88	124	160	196	232	268	304	340	376
18	72	28.3	17	53	89	125	161	197	233	269	305	341	377
19	76	30	18	54	90	126	162	198	234	270	306	342	378
20	80	31.7	19	55	91	127	163	199	235	271	307	343	379
		33.3	20	56	92	128	164	200	236	272	308	344	380
21	84												
22	88	35	21	57	93	129	165	201	237	273	309	345	381
23	92	36.7	22	58	94	130	166	202	238	274	310	346	382
24	96	38.3	23	59	95	131	167	203	239	275	311	347	383
25	100	40	24	60	96	132	168	204	240	276	312	348	384
		41.7	25	61	97	133	169	205	241	277	313	349	385
26	104												
27	108	43.3	26	62	98	134	170	206	242	278	314	350	386
28	112	45	27	63	99	135	171	207	243	279	315	351	387
29	116	46.7	28	64	100	136	172	208	244	280	316	352	388
30	120	48.3	29	65	101	137	173	209	245	281	317	353	389
		50	30	66	102	138	174	210	246	282	318	354	390
31	124												
32	128	51.7	31	67	103	139	175	211	247	283	319	355	
33	132	53.3	32	68	104	140	176	212	248	284	320	356	
34	136	55	33	69	105	141	177	213	249	285	321	357	
35	140	56.7	34	70	106	142	178	214	250	286	322	358	
		58.3	35	71	107	143	179	215	251	287	323	359	
36	144	60	36	72	108	144	180	216	252	288	324	360	

Figure 3. Chart designed to give facts needed in the preparation of narration to match length of scenes.

All 16 mm sound projectors accommodate the large 1600 foot reel, which in turn accommodates four 400 foot reels of film. Each 400 foot reel of sound film has a screening time of approximately 10¾ minutes, so a full 1600 foot reel has a screening time of about 43 minutes.

Animation and Art Work

In recent years, animation has become an important factor in the preparation of teaching films. The many and varied technics employed make this an ideal medium for the visual explanation or portrayal of those facts and factors difficult or impossible to visualize by other methods.

The word "animation" covers far too much territory. It seems that everything not done by straight photography is now called "animation", so to promote a better understanding of this phase of production some explanation is in order together with a general classification of the technic involved.

First let us explain a few fundamentals. To do this we had better start at the beginning.

There is no such thing as moving pictures. As you know, the pictures do not move. We photograph action by making a series of still pictures, or images, in rapid sequence on a continuous strip of moving film. When projected in like sequence our own "persistence of vision" supplies the motion.

There are 40 frames or pictures to each foot of 16 mm film and each frame, or picture, is slightly different from the one preceding—each registering the "stage of motion" at the exact time of exposure. If we make a movie of a simple action, such as the movement of an extremity, we will find on close examination that we have a definite number of pictures, each picturing the extremity in a slightly different position.

Now, if we want to make this scene in animation, we will have to make a drawing of each of these pictures (40 to the foot) each an exact replica of the individual frame, or "stage of motion"—and each in "exact" registration. We will then have to mount these drawings in a frame and will have to photograph each one of them individually in sequence on a strip of film.

As the background, or parts of it, will no doubt remain stationery, we can save considerable labor in drawing by making one picture for the background and making the other drawings on transparent material. Then in photographing the sequence, we have only to change the transparent sheets each time we photograph a frame or picture, leaving the background in place.

This should serve as a simple example, but in actual practice the work is much more complicated. A general classification might be as follows:

A. *Extreme Progressive Action*—such as the slow but gradual development of an embryo, or the growth of a fetus and birth of a baby. Here the action is rather complicated and progressive—no frame or picture is like any other, and there is no possibility

of repeating any part owing to the absence of any cycle. Every part of our picture is undergoing a gradual and continuous change, so each drawing (40 to a foot) must be complete and exactly in register with the one preceding, except where action progresses in certain areas.

B. *Simple Progressive Action*—such as the passage of stones through gall bladder and ducts, wherein much of the background can remain practically fixed and the movement of the stones carried on transparent overlays. If a stone becomes lodged at some point causing an extension of tissue, ball-valve action, or some other manifestation then a greater number of drawings are required.

C. *Semi Progressive Action*—wherein one simple progressive action may combine with cycle action. Cycle action is so called when we can time and execute our drawings in such a way as to come back to a common point. Then by repetition in photographing we can secure the footage required.

D. *Complicated Line and Cycle*—wherein there are many actions but all in cycles of say 12 to 24 drawings, or "cells". Each action can be carried on a separate series of transparent drawings of a simple line type.

E. *Simple Cycle Action*—wherein a cycle of action can be repeated for study—so made that a series of drawings can be made and photographed in sequence to make up the length of scene required.

F. *Stop and Lap Action*—wherein stages of action are shown by fading, or dissolving from one stage or drawing to another—with captions, arrows and other explanations flashing in, dissolving in and out, etc.

This is a simple classification, but in practice we find that animated scenes usually involve parts of all or several of these classifications. Technics are many and varied, so in planning the work it is important that we consider these factors carefully and employ the simplest and most direct method of accomplishing our purpose.

From experience we have found it wise to deal with most subjects in a simple manner, unless budgets are such as to permit us all necessary latitude in the development and completion of an exact and exacting project.

In dealing with fundamentals or principles a simple technic is always best. It is more effective, invites less criticism and is much less expensive. Even in the treatment of subjects where anatomy must be pictured we have found it wise to simplify our drawings as far as possible. This is usually necessary to keep costs in line, and while we have occasionally

heard the criticism, or suggestion, that our drawings are not sufficiently detailed, we have been in difficulty only when we have endeavored to picture anatomical structures in all detail possible. Honest differences of opinion must be reconciled.

On one occasion we had our layouts and drawings checked by several authorities on anatomy, physiology and medical art. In the process we naturally met with differences of opinion, but in due course arrived at the point where these minor differences were reconciled. We then completed the work only to have it criticized at a later date. Following a careful investigation of each point in question we later learned that all of this criticism was a matter of opinion on the part of various individuals, who were so anxious to find points of controversy that they overlooked the real purpose of the presentation. They could not see the forest because of the trees.

Since then we have endeavored to avoid all unnecessary detail and have concentrated on the presentation of the fundamental principles involved.

We believe we have demonstrated the importance of having a complete working script prepared and approved before starting any picture taking. However, there are many other reasons too numerous to detail here.

Application of Film Program

To secure a satisfactory return on any motion picture investment it is essential that the films be used extensively for the purpose intended. As we have explained, the motion picture is only an aid to teaching and cannot do the job alone. While this medium has many advantages it also has some disadvantages.

The principle disadvantage is that it encourages laziness on the part of instructor or student. It looks too easy. Therefore, intelligent application is essential—the use of the film must be directed.

The idea that large groups need only to be *exposed* to a teaching film to come away with a complete mastery of the subject content is completely false. The instructor makes or breaks the usefulness of the film.

We cannot over-emphasize the importance of intelligent tie-up and as so few teachers in medicine have had instruction in the efficient use of visual aids, we suggest that for each subject there should be prepared a complete and detailed *suggested* procedure. To give you an idea as to how this might be done, we will explain how several of the ethical manufacturers have solved the problem.

As an example, one firm will send their film program only to selected groups by special arrangement—and on their agreement to give the subject full and generous discussion. To assist the group in accomplishing this they have prepared:

1. A manual or guide for the chairman.
2. A scientific paper on the subject, this being a carefully prepared digest of material published by authorities, with proper credit, together with an intelligent analysis of the whole. This paper has no author indicated although its source is known.
3. A list of scenes, sections, digest and highlights of the film—together with *suggested* commentary.
4. A guide to discussion—questions and answers—and—
5. True-False Quiz. These are filled in and kept by each person in attendance—after being told how to mark and score himself. No one but himself knows how he made out.
6. A simple booklet—pocket size— digesting the subject in Atlas style—an authoritative illustrated reference illustrated from the film.

The results have been so successful that the sponsor is planning several new projects—two of which are now in production. They are true teaching films—with no possible commercial tie-up except statement of sponsorship. This firm is honestly endeavoring to serve the profession in an unselfish manner—and in so doing has learned what the medical schools should have learned for themselves a long time ago. Surely, we can learn from the experience of others.

Producer's Problems

No two projects are alike. One film may involve nothing more than surgical or clinical photography with captions or titles inserted when editing. The next may involve animation, medical art, microscopy or many other specialized technics. One may be completed within a few days while the other may involve several months' work.

So you can readily see, it is impossible to estimate the cost of any project with any degree of accuracy until the producer has a detailed and approved script—or blue print from which to work. He must know how much work is to be done, where it is to be done and when it is to be done. He must be able to estimate the number of man hours and cost of materials the project will consume together with many other expenses. Yet the first question invariably asked of the producer—usually at the first discussion of the project—is "What will it cost?"

Until a working script is completed and approved there can be no answer to that problem except, "How long is a string?" or "How deep is the ocean and how high is the sky?"

Even when the producer lavishly expends his time, knowledge and

effort in the development of such a script, there is an overwhelming tendency to insist on changes, revisions and remakes, usually after the work has been done at least once. In most cases such changes are second guesses, last minute thoughts, or ideas for "improving" some of the scenes, stimulated as a result of the first showing.

We have had several experiences where we have done everything possible, at our own expense, to get things on paper and thoroughly understood in advance—only to have things changed again and again during production—also at our expense. A perusal of our files on one project in particular will be most enlightening.

In this case the sponsor set the stage, dictated the rules and pinned us down to a contract. During production the contract was forgotten by everyone but ourselves, and if we even mentioned the existence of such a thing we were told by all and sundry to forget it—that the film must be done right—and we would be taken care of. It was and we were—in reverse—and in a manner which resulted in much confusion and financial loss to ourselves. We stayed with it, however, until the picture was completed and approved—*two years later.* Then, when we thought we had completed the project to the satisfaction of everyone, it started all over again. Before we were through the second time we had completely remade three reels of a four reel picture.

The film has finally been approved a second time and we have had many unsolicited expressions of approbation, yet those directing the work are still talking about *improving* the film. A successful teaching film is *always* a compromise. This is to be expected, but in this case: *"The operation was a success but the patient died."*

It's tough to make a movie
For those who want to change it.
Who say: "That's fine, just what we want
But let us rearrange it.
Let's move the building over,
And give the man a cane
And add an umbrella
In case it starts to rain
And change the girl's expression
To one of glad surprise,
And if it isn't too much trouble
Let's change the color of her eyes.
Don't clutter up the picture
With meaningless detail
But get a clock in somewhere
With a boat about to sail.
And I suggest a troop of soldiers
And a fat man with the gout
Then add a railroad station
With the train just pulling out.
The man is running for the train
And fears he may be late;
So have him looking at his watch
With the hands at half past eight.
But don't get the thing too crowded
We must have room for copy
But give the girl galoshes
Because the weather's sloppy.
And make the oak a maple
And make the horse a cow
And make the hen a rooster
And make the rake a plow.
With these few minor changes
Everything's now okay
But we *must* have the movie
For our lecture yesterday.

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Association News

Committee Report on Motion Pictures

13th Report of the Committee on Motion Pictures, 1946

I. Films Reported by Our Members

C. Lloyd Claff: Cardic resuscitation, operation by M. Fanteau. C, 1097′.

Stephen P. Dittman: The care and rehabilitation of spinal cord injuries. No data given.

Wyne Eastman: Vaginal hysterectomy for complete procidentia cystocele and rectocele. C, 700′.

L. J. Gier: Plants and animals in National Parks of the Canadian Rockies, Pacific Coast and Grand Canyon, made during trip. C, 720′.

Charles Lindsay: Intracapsular cataract extraction (with sliding conjunctional flap) and intercapsular cataract extraction. C, Si, 16 mm, 730′; Osteoplastic craniotomy. C, Si, 16 mm 1600′. Photography by John A. Mauer.

Wm. Harold Oliver: Beachcombing for marine life; reedited and retitled Seashore Oddities. C So, 800′. To be available through Young America Films, or Standard, of California Public Relations Dept.
Tomesha, geological and botanical aspects of Death Valley. C, So, 16 mm, 800′. To be available through Young America Films, Inc.

A. Pijer: Bacteria. (No data)

Clyde A. Prusman: Cinephotomicragraphy of life in pond water. C, 16 mm, 400′. Also planning to make color film of early development of chick embryo.

Henry Roger: Motion picture work on paper making, railroading, athlete's foot for Navy, various tropical diseases for Signal Corps and sound recording for various films.

Albert W. Slipp: Fungi pathegenic on forest trees with magnifications to 20 to show life cycle stages. C. (Not available)

Harold A. Thomas: Torus Palatinus. C, 16 mm, 100′; Operative procedure. Si; Operative procedure—extraction technic. A, Si, 16 mm, 100′. (Second and third not available)

C = color Si = silent, So = sound.

II. Catalogs

American Society for Pharmacology and Experimental Therapeutics, Inc. Committee on Visual Teaching materials: C. J. Carr, J. R. Wells, and R. P. Walton, Chairman, Medical College State of S. Carolina, Charleston, S. C., 12 pp. mimeographed. Seven pages of films one of organizations from which films may be obtained and 3 pages of lists of medical films. This committee is apparently modeled on that of the Society of American Bacteriologists and is another indication of the value placed on motion pictures for instruction. Members interested in pharmacology will do well to follow the activities of this able committee.

American Chemical Society. Bull. no. 2. Films on chemical subjects. 500 listed some on biology and public health.

Catalogue of films of general scientific interest available in Great Britain. Compiled by the Scientific Film Association. London. Pp. 188. 5s. Lists 595 films of which 298 have been summarized and graded (—*J. Sci. Insts.*, 1946, 23:303)

Health films. Am. Med. Assoc., 535 N. Dearborn Ave., Chicago 10. 2 pp. mimeographed, no data.

Medical Motion Pictures. *J. Am. Med. Assoc.*, 1945 129:138-139, A list of loan films. (Cf. address above under "Health Films")

III. Publications of Interest

Bogue, J. Y. Production of scientific films for biological and medical purposes. *Photo J.* 1945, 85B:27-31. *Am. Cinephot.*, 1945, 26:295, 318, 342, 346, 351. (From *Mo. Abst. Bull.* 1946, 32:329)

Giri, K. V. Films for science. *Sci. and Cult.*, 1945, 11(3):120-124. Kinds of films needed in India listed. From *Bi. Absts.*, 1946, 20:4246.

Medical motion pictures. *J. Am. Med. Assoc.*, 1946, 132:45. A list of the members, aims and scope of the committee.

Medical Motion Pictures. *J. Am. Med. Assoc.*, 1946, 132:239, 349, 407, 601, 535, 736, 878. Film Reviews.

Jones, Tom. Visual technics in medical education. *J. Assoc. Am. Med. Coll.*, 1946, 21:65-74.

Markee, J. E. Visual education in anatomy. *Ibid.* 75-80.

Morton, H. E. The use of visual aids in teaching of medical bacteriology. *Ibid.* 81-85.

Waters, L. The integration of visual education into the medical school curriculum. *Ibid.* 85-90.

Smiley, D. F. Some things we have learned about medical motion pictures. *Ibid.* 91.

American Society of Zoologists, Motion Picture Demonstrations. *Anat. Rec.* 1946, 96:13. Six films listed for the Boston meeting at Harvard University.

The Motion Picture Committee of the American Society of Zoologists for 1947 includes: Ralph Buchsbaum, Chairman, (U. Chicago), Robert Chambers, Jr., Edmund J. Farris, Oscar W. Richards and John Paul Scott.

Your committee invites you to send materials of interest and titles of your films for the next year's report to the chairman at the address below.

Ralph P. Creer
Harry E. Morton
Oscar W. Richards
Chairman,
Box A Buffalo 15, N.Y.

Back-Ordering Material in Our Journals

It is fully as important to make use of work already done as it is to forge ahead with new work. Interesting articles on the latest techniques are appearing in our Journals, but many of the articles that appeared in earlier numbers are still valuable. Indeed, the fundamentals described in them form the basis of much of the new work.

Members whose Journal subscriptions began with recent issues may wish to back-order material in their special fields. The Secretary has abstracts of all our published articles to date, and will gladly send you copies of those abstracts. Be precise, as it is difficult to select from the 300 or more articles that have appeared to date unless the specifications are definite. Most of the back numbers of the Journal are still in print.

Or copies of the articles you want may be obtained through the Bibliofilm Service, U. S. Department of Agriculture, Washington 25, D. C. Photoprints on paper, slightly smaller than the original pages, may be ordered at a cost of 50c for each ten pages or fraction thereof from a single volume. In case you have a microfilm reading desk available you may prefer microfilm copies, which may be obtained at the same address for a flat charge of 50c for any article in a single volume of a periodical. Order blanks may be obtained from the Bibliofilm Service or the B.P.A. Secretary. A separate order blank should be requested for each item to be copied. The images on both the photoprints and the microfilms are negative, unless positive images are specifically mentioned on the order blank. Positives cost twice as much as the prices for negative copies given above.

If you would like a complete microfilm copy of the back issues of the Journal through Volume 14, this too can be obtained. In this case, however, the copy would be supplied by the American Documentation Institute, % Offices of Science Service, 2101 Constitution Avenue, Washington, D. C. The Bibliofilm Service handles short runs and individual articles, while the American Documentation Institute supplies microfilms of entire sets of Journals. A negative of the first eight volumes of our Journal was made in 1941 and is on file at the Institute. At that time, the ADI quoted a price of $14.00 for a positive and from this negative of the first eight volumes, and added: "This is, to the best of our knowledge, the first instance where the publisher of a Journal has made it possible for his subscribers to obtain part or all of the material ever published in the Journal." Several positives from this negative have been sold by the Institute. In 1946 a negative was made of the next six volumes. The price of positive copies of the entire 14 volumes will be quoted by the Institute on request.

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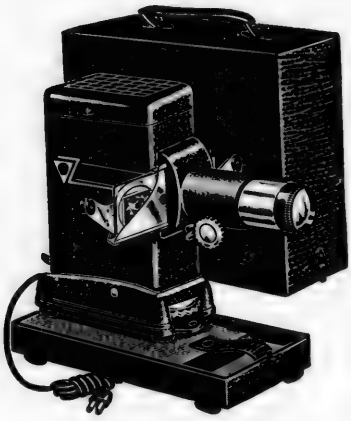

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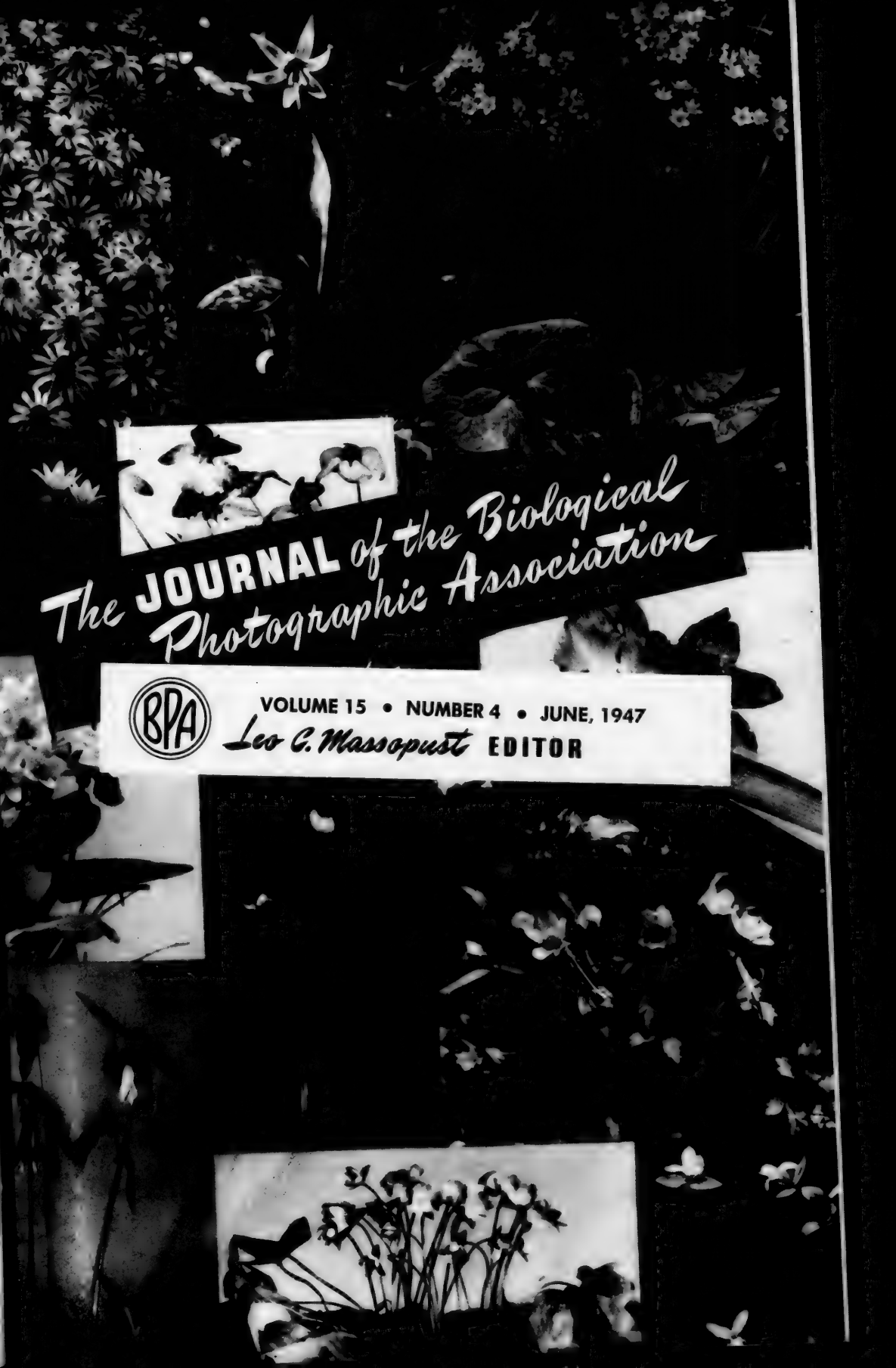

The JOURNAL of the Biological Photographic Association

VOLUME 15 • NUMBER 4 • JUNE, 1947

Leo C. Massopust EDITOR

Double Convention Attraction

1947 Convention
Biological Photographic Association
September 10-13, 1947
Rochester, New York

International Exhibition of Biological Photography
Closing Date — August 1, 1947
Opens with convention

The Program Committee is shaping an excellent program for the 1947 Convention. A notice appeared in the March number of the Journal requesting those who have papers to present to communicate with John V. Butterfield, Program Chairman, 635 St. Paul Street, Rochester, New York. A coupon was printed to facilitate matters. It should be pointed out that the convention is held for and by the members of the B.P.A. Although many lecturers may be and have been obtained who are not members, it is the feeling that MORE MEMBERS SHOULD CONTRIBUTE TO THE PROGRAM. So, clip out the coupon and send it to Mr. Butterfield.

Admittedly, the preparation and completion of a paper at this time is not possible for many of us, but a paper can be completed by the

(Continued on Page 207)

The JOURNAL of the Biological Photographic Association

Volume 15 • JUNE, 1947 • Number 4

Official Publication of the Biological Photographic Association

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Leo C. Massopust, Editor

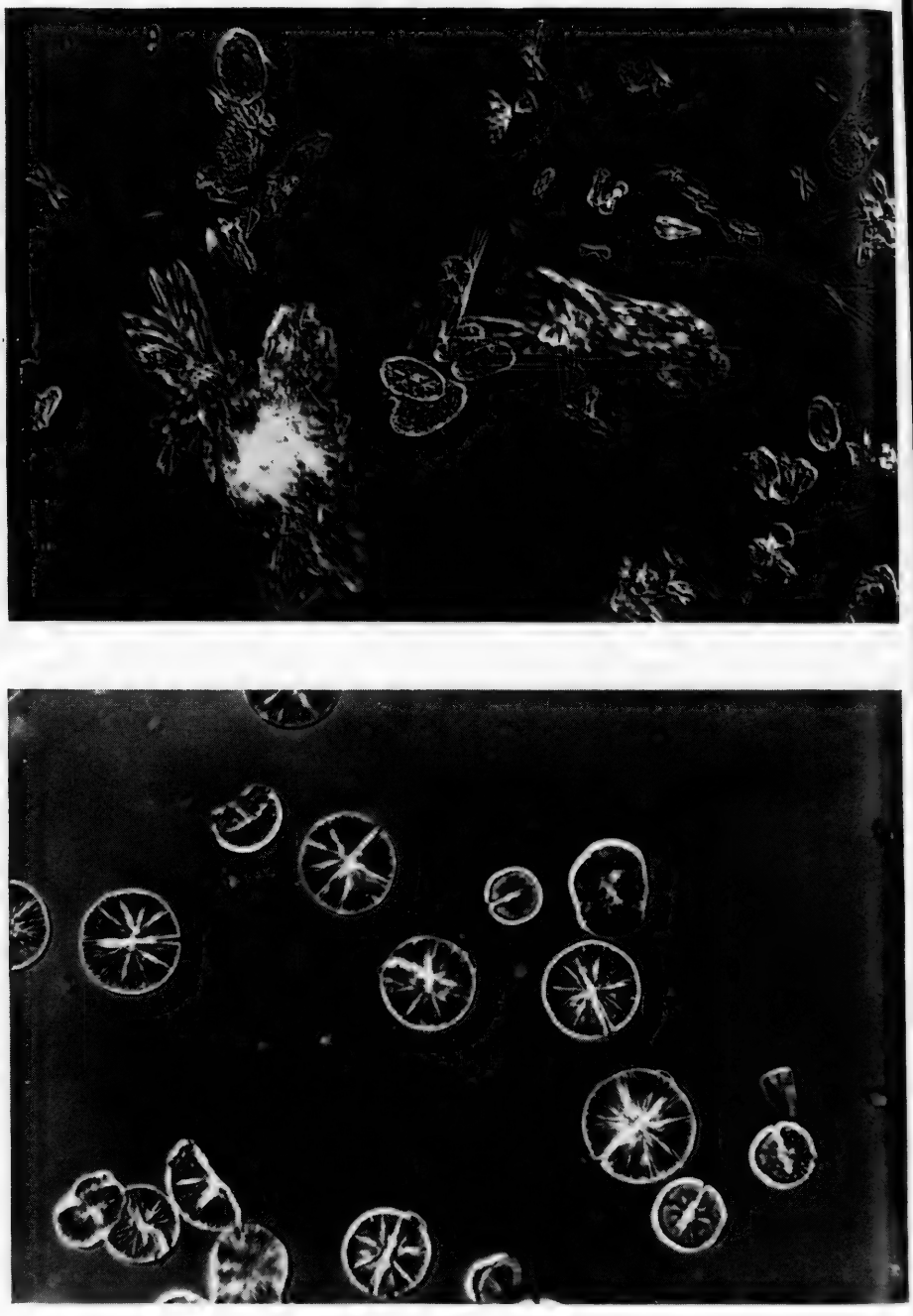
Marquette University School of Medicine

Milwaukee 3, Wisconsin

A S S O C I A T E E D I T O R S

ARTHUR W. PROETZ, M.D., Beaumont Building, St. Louis, Mo.; ANNE SHIRAS, School of Medicine, University of Pittsburgh, Pa.; FERDINAND HARDING, The Children's Hospital, Boston, Mass.; and ARTHUR W. FUCHS, 164 Inglewood Drive, Rochester, N. Y.

Published Quarterly at 561 North 15th Street, Milwaukee 3, Wisconsin. Entered at the Post Office, Milwaukee, Wisconsin, under the act of March 3, 1879. Subscription price $3.00 per volume; foreign countries $3.50. Single copies 75 cents in U. S. A.



Sulfa Crystals. Photomicrograph x 350. Bas Relief. John J. Beiter, Department of Photography, Rochester General Hospital, Rochester, New York.

Classifying, Indexing and Filing Medical Illustration Material

Edna K. Huffman, R.R.L.

BIOLOGICAL photography is a recent and rapidly expanding service rendered in present day hospitals. The photographer is the person responsible for filing the films, which is generally done in numerical sequence. The medical records librarian is logically the one to assume responsibility for safe-keeping and cross-indexing according to site, etiology or operative procedure of all slides and prints. Her department is generally either combined or closely associated with the medical reference books in research. Thus, the medical records department, the place where all data of a medical nature is centralized, should be the one to assume the responsibility for the correlation of the medical illustration material with medical records, medical reports and medical statistics.

With no known precedent to follow it was decided here that there would be an efficient correlation between the slides or prints, and the cases with which they are associated if the Standard Nomenclature of Disease and Operation code numbers were used for indexing, hence the following procedure was outlined:

1. All slides or prints are numbered as received and listed on the number index card.

#32

PHOTOGRAPHY INDEX

NO.	HOSP. NO.	NAME OF PATIENT	DOCTOR	DATE	F	S	K	DESCRIPTION
1140-K	117638	Smith, Helen	Black	7-2-46			x	Hernia, umbilical
1141-S	117568	Roe, Richard	Brown	7-2-46		x		Hallux valgus, bilateral
1142-S	117895	Jones, Mary	Blank	7-6-46		x		Flaccid paralysis following poliomyelitis with shortening of left leg

Our index may be more in detail than is needed but for fear that valuable information might be lost it was decided to indicate in addition to the slide number, the name of the patient, the physician, date, and legend as well as the hospital number on this card. The initial *K* is

Received for publication March 5, 1947, Chief Medical Records Librarian, Wesley Memorial Hospital, Chicago, Illinois.

used after the slide or print number to indicate Kodachrome; *S* for black and white slide; and *F* for print.

2. The black and white print is made when the original is a Kodachrome transparency. The idea of the print is to refresh the doctor's memory and thus save undue handling of the slides. An alphabetical patient's index was also started as it was found that many times the physician would come in asking for a slide by the name of the patient.

Jo

Case No.	Patient	Doctor	Slide No.
117895	Jones, Mary	Blank	1142-S

3. An individual site card was decided upon for each case. This card is coded according to the Standard Nomenclature site number and filed according to that number just as in a disease index. This card contains a 2 by 3 print of the slide. Thus, when a physician desires a series of slides for a lecture he can look over the cards rather than the

#1142-S Site: Muscles 278-

Jones, Mary 117895

E. R. Blank, M.D.

X-ray No. 4658

Paralysis, flaccid, following poliomyelitis, with shortening of left leg.

Osteoplasty with shortening of femur, right.

Admitted: 7-5-46.

Discharged: 7-23-46.

slides. In this way the slides will not have to be handled each time material is sought. This card carries the slide or print number, the name of the patient, hospital number, x-ray number (if any) the name of the physician, diagnosis, operation and date of admission and discharge of the patient.

4. A disease card is also filed under the complete Standard Nomenclature code number for that particular disease. This card shows all cases of that particular diagnosis, listing them under hospital number, name of patient, physician and print or slide numbers.

27.-564 Paralysis, flaccid, of ... following poliomyelitis

Case No.	Site	Patient	Doctor	Material
117895	278	Jones, Mary	Blank	1142-S
	279			
118045	279	Doe, Donald	Brown	1156-F; 1157-S

5. Each slide or kodachrome is labeled with the legend which indicates the number and diagnosis.

1142-S Flaccid paralysis,
following poliomyelitis

6. Each print is mounted by the photographer and placed in the chart for the patient to which it belongs just as laboratory and x-ray reports are put in the charts by those departments. It is indexed in the same manner and filed with the data on slides.

PHOTOGRAPHS

Name ..... **Room**.....**Hosp. No**.....

Physician ..... **Date**.....

7. When the photographer has a requisition for work and has taken the picture she stamps with a rubber stamp on the face sheet of the chart as follows:

Photograph—Date
Taken By

Thus, the medical records librarian knows she may expect material if it has not already been received by the time the patient is discharged and the chart received. When prints or slides have been received and are indexed a notice is sent to the attending physician stating that the material is available on loan in the medical records library.

8. It is the responsibility of the photographer to obtain a permission for the photography signed by the patient or in case of minor by the parent or guardian and this is also filed with the medical record.

CONSENT TO PHOTOGRAPH

Name .....**Hosp. No**.....
Physician ..... **Photograph No**.....

I hereby give my consent to have photographs made of myself to be used for educational purposes or to be published in scientific journals by Wesley Memorial Hospital or Staff, provided my name is not used in connection therein.

Date ..... **Signed** .....
Patient, or in case of minor, legal guardian

Witness.....

Slides are requisitioned for classes for the medical students and others just as are charts and must be returned at the close of the class. They are sent out in a portable slide file to avoid breakage.

An Endoscopic Motion Picture Camera for Otolaryngology and Broncho-esophagology

J. D. Brubaker* and Paul H. Holinger, M.D.†

THE technical advances made in the endoscopic still camera previously described in this journal[1], have shown the desirability of making comparable changes in the basic design of endoscopic 16 mm motion picture cameras. A new camera is described here, in which such changes have been made. A very important advantage has been obtained by this change in design: the open-tube endoscopes used on the still camera may be used on either still or motion picture camera interchangeably. This is important since it is often desirable to take both still and motion pictures of the same area; thus, either camera may be attached to the endoscope while it is still in place.

The technical advances mentioned above are: (1) the use of a focusing type lens mount, permitting the use of several lengths of endoscopes on the same camera; (2) a coaxial telescope for finding and focusing, the telescope axis being coaxial with the endoscope and camera lens; (3) the use of a supplementary lens which permits photography at high magnification of the ear-drum. In addition, advantages of more convenient operation are obtained in the new design and are described elsewhere in this article.

The focusing type lens, and coaxial telescope finding and focusing make the new camera one of universal endoscopic type—similar in usefulness to the endoscopic still camera[1]. The primary uses are: photography through the *direct laryngoscope, bronchoscope,* and *esophagoscope; mirror photography* of the *larynx* or *post-nasal space;* photography of small areas of the *mouth* or *pharynx* not over 1¼ inches in diameter; photography of the *ear-drum.* The ability of the camera to photograph through almost any of the common open-tube endoscopes or speculums permits photography in the fields of *proctology* and *gynecology* by using special endoscopes made for the specific purpose. (Further details are given under "Other Uses").

Received for publication May 3, 1947.

* Design and Research Engineer, 805 Greenleaf St., Evanston, Ill.

† Ass't Professor of Laryngology, Rhinology, and Otology, Univ. of Illinois College of Med., Chicago.

The camera was constructed under the auspices of the Jacques Holinger Memorial Fund.

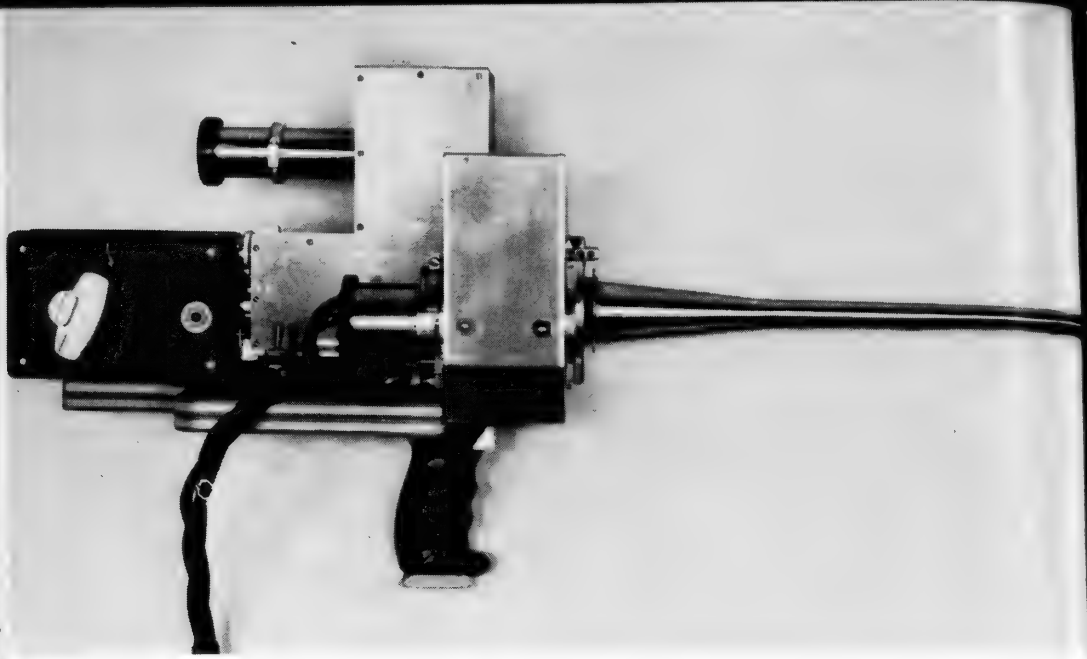


Figure 1. Right side of camera, with bronchoscope attached.

Before proceeding with the description of the new camera, a brief review will be made of some of the problems encountered in taking endoscopic motion pictures. For mirror pictures of the larynx, comparatively simple methods may be successful insofar as correct focus and camera alignment with the laryngeal mirror are concerned. Some motion picture cameras such as the Cine Kodak Special permit ground glass focusing until the instant the camera is started. If a method similar to that used by the Bell Telephone Laboratories[2] is used, wherein the laryngeal mirror is used on a fixed support, the problem of obtaining correct focus and field is simplified; the mirror is fixed in relation to the camera, and the mirror-to-larynx distance is approximately predictable. However, a trained subject is usually required when using the fixed mirror. Mirror photography is discussed further under "Technic".

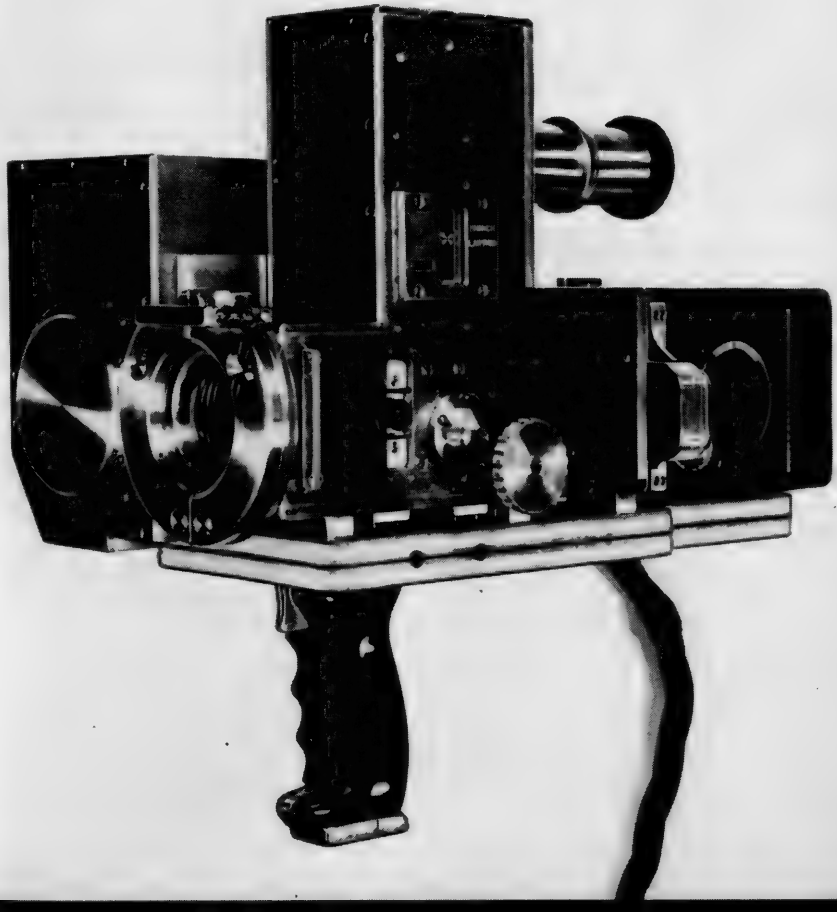
For photography of the larynx, using the direct laryngoscope, special methods of finding and focusing are required because the field is small and is close to the camera lens; cameras of lighter weight are desirable. A Goerz reflex focuser with the Bell and Howell 141 camera has been used for this purpose[3], but the focusing prism must be removed from the lens-to-film path before filming, and consequently the pictures are made blindly and the results are uncertain. The illumination method first used for color motion picture photography through the direct laryngoscope employed several otoscope lamps located near the tip of the laryngoscope[3]. The illumination obtained by this method is rather unsatisfactory for color photography since the illumination follows the inverse square law, and the light intensity falls off rapidly at greater distances from the lamps, and produces under-exposed pictures of the

distant parts of the field, with poor color rendition. Furthermore, the multiple reflections produced by the several lamps causes confusion when the finished film is viewed. Proximal illumination through open-tube endoscopes, using high wattage tungsten lamps, eliminates these lighting difficulties. Proximal illumination is necessary for photography of the bronchi and esophagus since there is not sufficient space to use incandescent lamps at the tip of the endoscope without encroaching upon the circular area of the field.

Blind filming is not satisfactory when taking pictures in the bronchi or esophagus, and the risk of trauma requires telescopic supervision of the field at all times while the camera is attached to the endoscope inserted in the patient. Continuous observation of the field and focus is necessary if motion pictures are to be made when the endoscope is advanced or withdrawn while filming; blind manipulation in this case is not possible from the standpoint of satisfactory photographic results.

When taking pictures of the larynx or bronchi, the necessity for

Figure 2. Left side of camera, showing attaching clamp, glass slide, supplementary lens slot, focusing knob, and focus indicator.



using a glass slide or other method, to shield the optical parts from gross soiling or condensed moisture, usually limits the choice to the proximally lighted type of equipment.

Therefore, when photographing through the longer endoscopes such as the bronchoscope and esophagoscope, special equipment is necessary which provides proximal illumination. Such equipment allows telescopic visualization of the endoscopic field during finding and focusing, and also when the camera is running. Special equipment also is desirable when photographing the larynx through the direct laryngoscope because of the superior quality of pictures obtained, and greater convenience of operation. Blind manipulation of laryngeal photographic equipment with consequent risk of trauma, is another reason for the preference of the more complex types of equipment which permit direct visual supervision of the larynx and endoscope tip at all times.

A review of the foregoing discussion, and of the camera description to follow, indicates that motion picture photography through the laryngoscope, bronchoscope, and esophagoscope cannot be done satisfactorily by purchasing an "attachment" for a motion picture camera. In fact, an examination of the equipment described in this article will show that the endoscopic motion picture camera consists of a rather complex optical apparatus which combines the light-source, camera lens, and focusing telescope in one unit, and the "motion picture camera" is used only as the film box. The equipment appears very complex, but it is easier and more convenient to use, and takes better pictures of the larynx than can be obtained with the simpler types of apparatus using a reflex focuser[3].

Endoscopic Motion Pictures as a Teaching Aid

The primary value of taking endoscopic motion pictures is in being able to show on the screen, in color, the view seen by the endoscopist as he explores the passage being examined, identifying each landmark in turn, before proceeding to advance or withdraw the endoscope. These motion pictures show the normal anatomy and function of the passages. The endoscopic appearance of inflammatory processes, tumors, and foreign-bodies also can be shown. Pictures have been made which demonstrate the endoscopic technics used to remove these small objects from the air and food passages where they have accidentally become lodged. The forceps are shown actually grasping the coin, tack, button or other foreign-body as it is removed.

Motion pictures make it possible to demonstrate the living appearance of the air passages with their characteristic motions caused by normal breathing and the mechanical pulsations produced by the heart

and nearby large blood vessels. Similar typical pulsations occur in the esophagus. Such normal motility of the structures plays an important part in diagnostic technics, especially in the air passages, since lack of them may indicate and help identify certain abnormal conditions. Motion pictures help the specialist to give students, physicians, and other medical personnel, a working knowledge of endoscopic technics—knowledge far more complete than that obtained by occasionally looking down an endoscope in the bronchoscopic operating room.

A realistic sense of perspective is usually seen in endoscopic motion pictures because of the constantly moving lumen, tipping at an angle

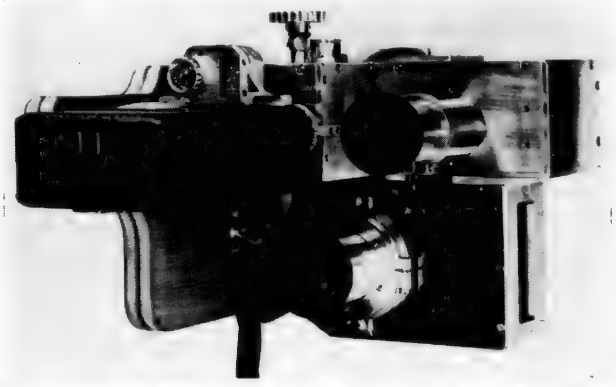


Figure 3. Rear view of camera, showing mask-setting knob, and f. stop knob.

to the endoscope axis. The procedure of scanning the field, showing successive landmarks each in turn, also contributes to this simulated stereoscopic effect.

This sense of perspective and realism is of more value than the true binocular vision effect produced when viewing actual stereoscopic still pictures; the element of motion, combined with the perspective sense, is important.

Description of Camera

The new endoscopic motion picture camera is similar in some respects to a type previously constructed[4,5,6,7]. The light-source, focusing telescope, and camera are combined in one unit. An attaching clamp at the front of the unit permits the instant attachment or detachment of any of several endoscopes or light-reflecting tubes, used to photograph the various areas. A heated removable glass slide placed immediately behind the attaching clamp, shields the optical parts from gross soiling or condensed moisture. The apparatus is held by a built-in handle when photographing through the endoscopes, or supported on a tripod for mirror photography of the larynx. The camera is started

and stopped by a trigger lever in the handle which also automatically raises the lamp voltage to the proper color-temperature while the camera is running. The plane of sharp focus, at the object, is adjustable and may be placed at any position from 9 to 26½ inches from the attaching clamp. The telescope and camera are focused simultaneously by a knob on the left side of the housing. The telescope shows an exact duplicate of the film image during finding and focusing as well as while the camera is running. A slot permits the insertion of a supplementary lens for photography of the ear-drum at a relatively high magnification. (A detailed discussion and comparison of the old and new type cameras is given in the appendix at the end of this article). The following description deals with each portion of the camera separately, to show the basic design and theory underlying its operation.

Many details of the motion picture camera and its endoscopes are similar or identical to those of the still camera[1]. In order to avoid too many references to the previous article on the still camera, and to avoid confusion, some details of the description will be repeated. The reader is urged to study the article on the still camera for a better understanding of the endoscopes, and of the differences of technic in still and motion picture photography.

Endoscopes

The endoscopes used with this motion picture camera are exactly the same as those used with the still camera previously described in this journal[1]. The full verbal description of the endoscopes will not be repeated here. However, the drawings of the endoscopes shown in figure 6-a are identical to those shown for the still camera. The bronchoscope, esophagoscope, laryngoscopes, and mirror-tube all are directly interchangeable on either camera. The minimum focusing range of adjustment of nine inches for the motion picture camera permits the use of special short endoscopes whose free working length is not less than four inches. For example, a special laryngoscope (figure 6-b) may be used which is 11 inches long (instead of the standard 13½ inches). This gives a free working length of 6 inches and produces a larger image on the film and shows finer detail. The maximum focusing distance of 26½ inches was planned for the possible use of an open-tube gastroscope; however, the size of the film image at this distance is at this time too small for satisfactory results.

The illumination system produces approximately the same standard light intensity at the tip of any endoscope or light-reflecting tube whose diameter is one inch or less. The surface and oral cavity tube used with the still camera cannot be used on the movie camera because the illumination is unevenly distributed when it is used, and the light intensity is too low for proper exposure of the 16 mm type A Kodachrome film

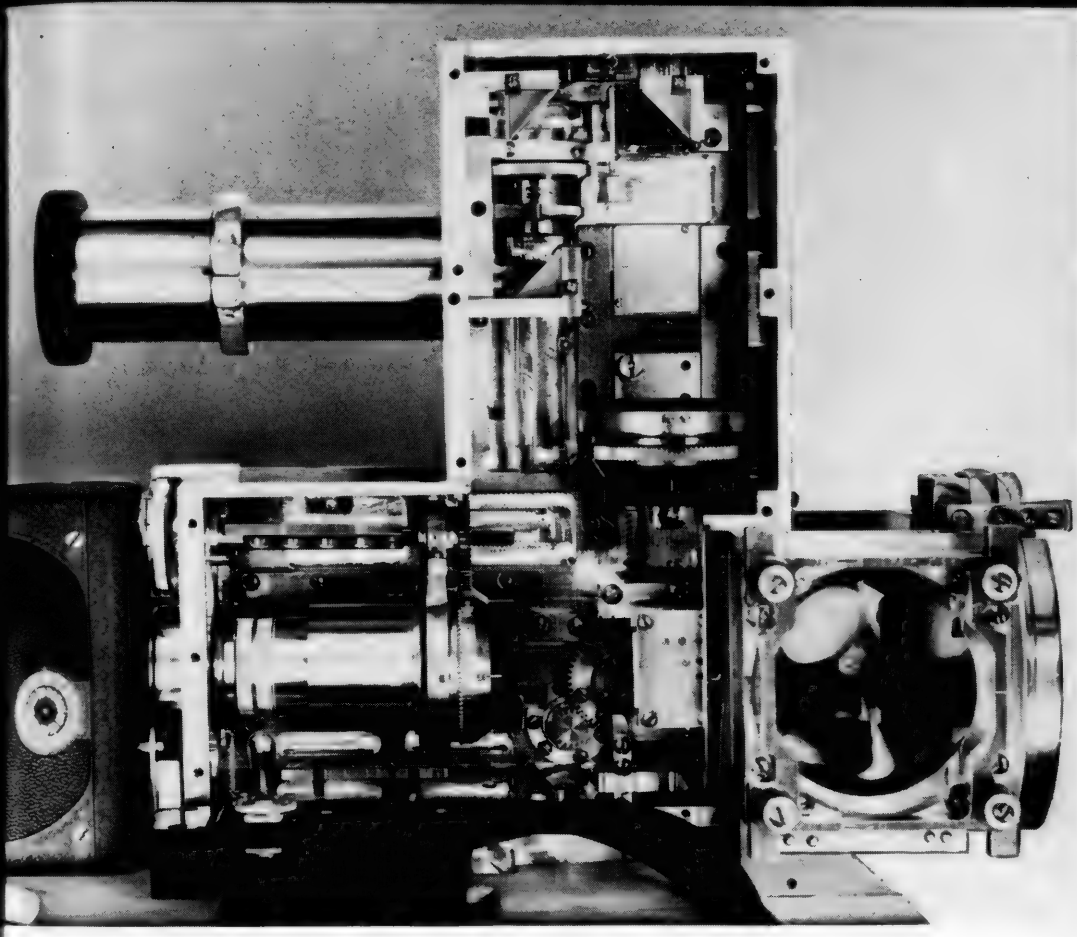


Figure 4. Interior of camera with cover and lamphouse removed.

Instead, a light-reflecting tube approximately one inch in diameter is used. The mirror tube, without the mirror, may be used for this purpose. Figure 7 shows the relation between field size, size of image on the film, and image/object ratio.

The endoscopes and light-reflecting tubes are polished and nickel-plated on their inner surfaces. Near the tip of each endoscope the interior surface is threaded for one-half inch to help outline the circular field. This is necessary since it is impractical to arrange the masking device to mask close to the circular film image. Thus, slight bending of the endoscopes during filming allows the image to change position slightly in relation to the mask opening without wandering off the field.

Attaching Clamp

The attaching clamp permits instant attachment or detachment of any of several endoscopes or light-reflecting tubes. The clamp makes a solid mechanical connection between the endoscope and camera. The endoscope axis is aligned accurately with the camera axis so that the image of the endoscope tip comes in the center of the camera film aperture, and is approximately centered in the mask opening.

Glass Slide

A heated glass slide is used immediately behind the attaching clamp to shield the optical parts of the camera from gross soiling or condensed moisture. A rectangular opening at one side of the front face of the glass slide allows passage of air through the endoscope to permit the patient to breathe freely when the bronchoscope or direct laryngoscope is used. The glass is optically flat and introduces no aberration into the film image. It is placed at an angle of five degrees to avoid reflections. After the initial heating of the slide, the heat absorbed continuously from the camera lamp bulb keeps the slide warm enough to avoid fogging.

Illuminating System

An airplane headlight (landing light) bulb is used as the light-source in this camera. It was chosen because its two compact filament coils occupy a very small space about 5 mm square, and because this lamp can be operated on its side instead of in an upright position. The technical description of this airplane tungsten filament lamp is: 240 watt, 12 volt, 20 ampere; medium pre-focus base; C-2 type filament; A-19 bulb (2⅜ inches in diameter); total lamp length 4⅛ inches.

The light from this lamp is directed onto the main axis of the camera by means of two condenser lenses and the plane mirror at 45 degrees (figure 8). A spherical mirror behind the lamp increases the light level and produces more even illumination. An enlarged image of the lamp filament is projected to a plane about 5 inches ahead of the attaching clamp. This is the optimum distance in order to produce the maximum light level through the endoscopes and light-reflecting tubes.

A heat-absorbing glass is used between the condenser lenses to absorb excess heat from the lamp. This is necessary because the heat reaching the tip of the endoscope is slightly greater than the mucosal surfaces can tolerate with safety. An additional heat-absorbing glass is used in the ear-speculum attachment (figure 6-b) to reduce the heat still further when photographing the ear-drum. This second heat-absorbing glass has a hole in the center so that the light to the camera lens does not traverse the glass. Both heat-absorbing glasses are of the new high efficiency type recently announced by the American Optical Company; the glass is nearly colorless and absorbs little light.

The lamp is operated at 12 volts while finding and focusing, and is raised automatically to 14½ volts while the pictures are being taken (by means of a relay operated by the camera trigger, figure 9). This produces light of approximately 3450 K, the correct color-temperature

for type A Kodachrome film. The estimated life of the airplane lamp at 12 volts is about 50 to 100 hours. When operated at 14½ volts, the life is about 30 minutes actual filming time which permits approximately 750 feet (15 magazines) of film to be taken with one lamp.

A light intensity of about 160 candles-per-square-foot is obtained at the endoscope tip when the lamp is operating at 14½ volts. This corresponds to a lens setting of f. 8 at 1/40 second for type A Kodachrome film. Due to light absorbed in the glass slide and beam-splitter cube, the actual stop is about f. 6.3 at the camera lens when photographing average-colored areas.

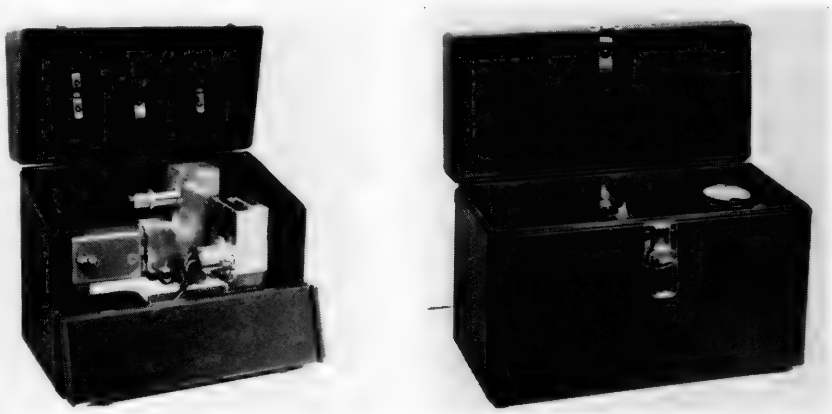


Figure 5. (a) Camera in carrying case. (b) Control box.

The light intensity at the ear-drum, through the ear-speculum is about 650 candles-per-square-foot, corresponding to a lens setting of f. 16 when a lens is focused at infinity. Although some light is absorbed in the beam-splitter cube, and the lens extension ordinarily requires a larger stop, a marked f. stop setting of f.11 to f. 16 can be used.

In order to check the actual photographic light intensity at the tip of the endoscopes and light-reflecting tubes, a GE exposure meter is used. This permits a periodic over-all check of the proper lamp alignment, lamp blackening, and internal endoscope reflectivity; these factors may affect the proper exposure of the film by causing a reduced light intensity. The meter is used in an empiric manner. The incident-light method is used, with a ⅛ inch hole in an opaque mask covering the photo-cell. A standard light-value is determined by measuring the light intensity at the endoscope tip which produces satisfactorily exposed film, with proper color rendition. A reduction of more than 25 per cent in light value usually requires replacement of the lamp bulb.

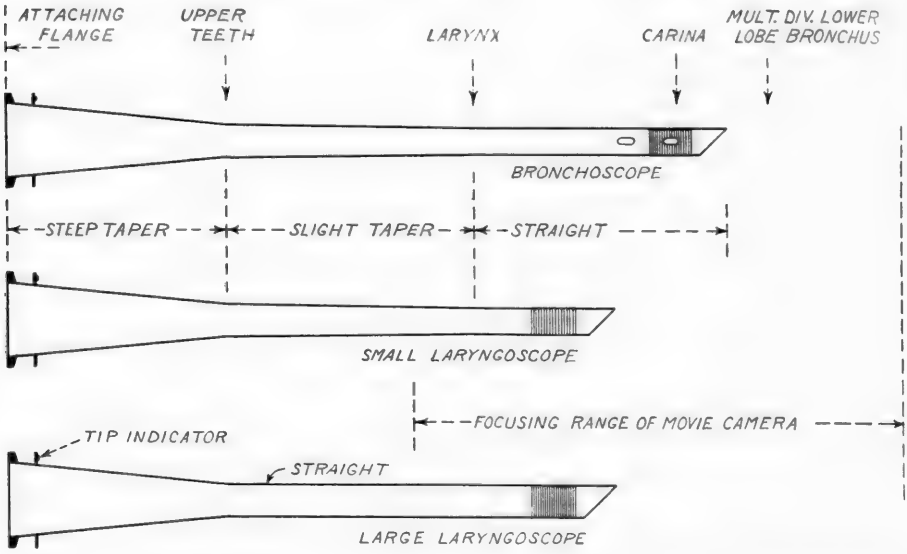


Figure 6-a. Sectional views of endoscopes (approximately to scale). These are interchangeable between motion picture and still cameras.

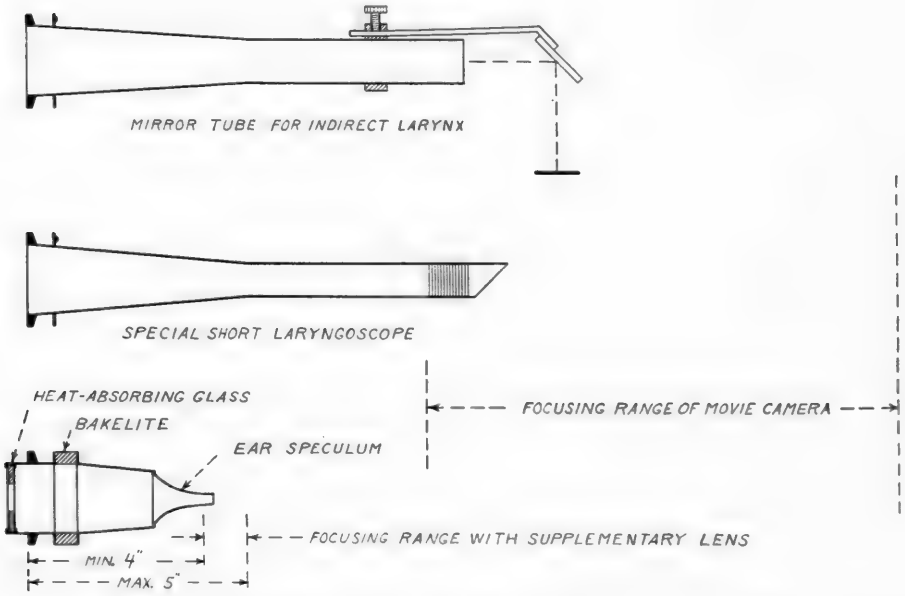


Figure 6-b. Sectional views of attachments (approximately to scale). Mirror tube is interchangeable between motion picture and still cameras.

The light distribution at the tip of the endoscope and at the tip of the ear-speculum is even, and no image of the lamp filament, on the field, is noticeable in the finished pictures. The light intensity beyond the endoscope tip and mirror tube tip is uniform enough for satisfactory photography of areas up to about three or four inches beyond the tip. For example, a normal level of illumination is obtained at the plane of the larynx when the mirror tube is used.

The lamp-house is insulated mechanically from the main camera housing to reduce the heat-conduction from lamp-house to camera housing. Some of the heat absorbed by the camera housing is conducted through the attaching clamp to the endoscope flange, and slightly heats the endoscope. The total heat conducted is not excessive for the endoscopes, but it is excessive when transmitted to the ear-speculum. Therefore the ear-speculum holder is insulated mechanically with a ring of bakelite to prevent the mechanical conduction of heat to the speculum (figure 6-b).

Safety of Electrical Circuits

The electrical circuits reaching the camera are at a low voltage and are well insulated from the 115 volt a.c. line (figure 9). The low-voltage circuits are insulated from the metal camera housing, and the transformer windings supplying the low voltages are well insulated from the line. With this arrangement, complete safety is provided against electrical shocks to operator or patient.

Optical System

The basic optical arrangement allows both the camera lens and the focusing telescope to operate on the same axis, and uses the same supplementary lens for higher magnifications. Figures 4 and 8 illustrate the following discussion.

Through the use of a "beam-splitter cube" the camera and focusing telescope view the field at the same time. This beam-splitter cube consists of two right-angle prisms with their hypotenuses cemented together. Before cementing, the hypotenuse of one prism is coated with a very thin partially reflecting aluminum coating. Most of the light reaching the cube passes straight through it to the camera lens. About 15 per cent of the light is diverted at 90 degrees, to the telescope objective lens.

The camera lens and telescope-objective lens are identical. They are a matched pair of 90 mm focal length Wollensak Velostigmats, Series 2. The lenses are of exactly equal focal length, and are of f. 4.5 aperture. They are of the coated type (with anti-reflection coating) for improved light transmission and improved image contrast. The maximum usable aperture for both lenses is limited to f. 5.6 by the

dimensions of the beam-splitter cube, and by the tube through the 45 degree mirror.

The two lenses are moved simultaneously by a knob with rack and pinion motion, through equal distances, and without any backlash or play in the gearing. Friction holds the focusing knob wherever it is stopped. Since the focal image planes are fixed in position, the motion of the lenses moves the object plane of sharp focus farther or closer in relation to the attaching clamp, and in this way, the camera lens and telescope are always focused upon the same plane in the object space. The supplementary lens simply shifts both planes of sharp focus a certain distance toward the attaching clamp. With the supplementary lens, the focusing action is basically the same as with the regular endoscopes, but through a shorter distance.

Focusing Telescope

The focusing telescope is an extremely important part of the camera. By means of the telescope, the field at the endoscope tip is constantly under visual supervision, allowing safe manipulation of the endoscope in order to reach the desired field for photography, or for observation of the field while the endoscope is advanced or withdrawn while filming. The telescope enables the plane of sharp focus for the camera to be placed at any distance beyond the endoscope tip; the plane of sharp focus may be changed while the camera is running. The field is seen at all times, while filming as well as before and after taking the pictures. Experience has shown that the mucosal surfaces of low contrast can be focused upon more accurately by using the aerial image and therefore no ground glass is used at the eyepiece focal plane. The telescope is adjusted to produce correct focus for the camera when the eye is relaxed and focused upon infinity—similar to looking into a microscope. The eye-point is far enough away from the eye-cap to permit the operator to wear glasses. The camera is designed for a right-handed person, and for the right eye at the telescope.

The image in the telescope eyepiece is erect and correct from side to side, the same as though the operator were looking dirctly into an endoscope. The optical system must provide this correct image, since an inverted or transposed image introduces serious risk of trauma when the endoscope is manipulated.

The total magnification of the field as seen in the telescope eyepiece is about five times for the endoscopes, and about ten times for the supplementary lens distance.

A focus indicator is provided in a window at the side of the main housing to show the position of the plane of sharp focus ahead of the attaching clamp. The indicator may be moved by the focusing knob,

to the position marked on the scale corresponding to the endoscope used. Without such an indicator, it would be necessary to move the focusing knob while observing through the telescope with a sterile cloth held just beyond the endoscope tip in order to make the focus setting—a source of annoyance and lost time in the busy operating room. The pre-setting method by means of the indicator is sure and rapid.

IMAGE/OBJECT RATIO and SIZE of FILM IMAGE

DISTANCE FROM ATTACHING-CLAMP FLANGE Inches	Image/Object ratio of magnification on the film (Image/Object diameter)	Field at object corresponding to max. possible film image dia. Inches	Image Circle dia. on film corresponding to endoscope tip. Inches
19 3" Beyond tip of Bronchoscope	0.17	$1\frac{1}{2}$	.095
16 At tip of Bronchoscope or Esophagoscope	0.21	$1\frac{1}{4}$	.115
$13\frac{1}{2}$ At tip of small Laryngoscope	0.25	1	.130
$13\frac{1}{2}$ At tip of large Laryngoscope	0.25	1	.165
$13\frac{1}{2}$ $3\frac{1}{2}$" Beyond tip of mirror tube	0.25	1	.250
11 At tip of special Laryngoscope	0.32	$\frac{3}{4}$	.210
AT SUPPLEMENTARY DISTANCE (focusing range 4 to 5 inches)			
$4\frac{3}{4}$ 6mm dia. Ear Speculum	0.50	$\frac{1}{2}$	.125

Figure 7.

Camera Film-Box and Photographic Lens

The motion picture camera box is a Bell and Howell Auto Load. It is permanently attached to the main housing of the endoscopic camera. The release button is operated by the trigger in the handle. The Auto Load camera uses 16 mm type A Kodachrome film in 50 foot

pre-threaded magazines and runs about 12½ feet at one winding. This corresponds to 31 seconds of filming time at 16 frames per second. While the normal shutter speed of this camera is 1/43 second at 16 frames per second, the shutter blade opening was increased to allow the light from the lens to remain on the film for a longer period of time, permitting the use of a slightly smaller f. stop. The new shutter speed is 1/34 second. This change is possible because the film image is limited to a circle 0.250 inch in diameter.

The camera model chosen provides for the choice of 8, 16, 24, or 32 frames per second. A speed of 16 frames per second is ordinarily used at f. 5.6 to f. 6.3, but a speed of 24 frames per second is possible at f. 6.3 to f. 8 for direct photography of the larynx where much light is reflected from the photographic field. This slows down the rapid action of the vocal cords and gives the finished picture a more normal appearance.

A special masking device is built into the left side of the camera film box in order to mask off the out-of-focus images reflected from the inside of the endoscopes, figure 3,8. The mask is a metal strip with a series of four holes of graduated sizes corresponding to the film image diameter of the various endoscope tips. The largest opening is 0.250 inch in diameter. The strip is moved by a small knob, figure 3. Each hole selected is centered automatically in the film aperture by a roller which drops into detent notches in the mask strip. The mask is 0.250 inch ahead of the film, and it masks fairly close to the circular film image, with only a small margin of the endoscope wall visible in the finished picture. Without such a mask, the bright out-of-focus images reflected from the inside of the endoscopes would distract attention from the circular field of view. With the ear-speculum it is possible to mask down to the exact diameter of the speculum tip.

As previously stated, the camera lens is a 90 mm focal length f. 4.5 anastigmat type. The maximum usable aperture is f. 5.6. The f. stop is adjusted by a knob at the rear of the main housing. F stops of 5.6, 6.8, 8, 9.5, 11, 13.6, and 16 are provided (one-half stop intervals). The maximum circle of confusion on the film, due to aberrations of the lens, is less than 0.001 inch. In other words, a geometric point at the object plane of sharp focus is imaged as a circle smaller than 0.001 inch at the film plane. This is entirely adequate for the best quality motion picture photography on 16 mm Kodachrome film, and is the accepted standard for the best lenses used with 16 mm cameras.

The size of the film-image circle for each endoscope is shown in figure 7. The bronchoscopic film image is 20 per cent larger than on previous cameras used for per-oral endoscopy, due to the longer focal

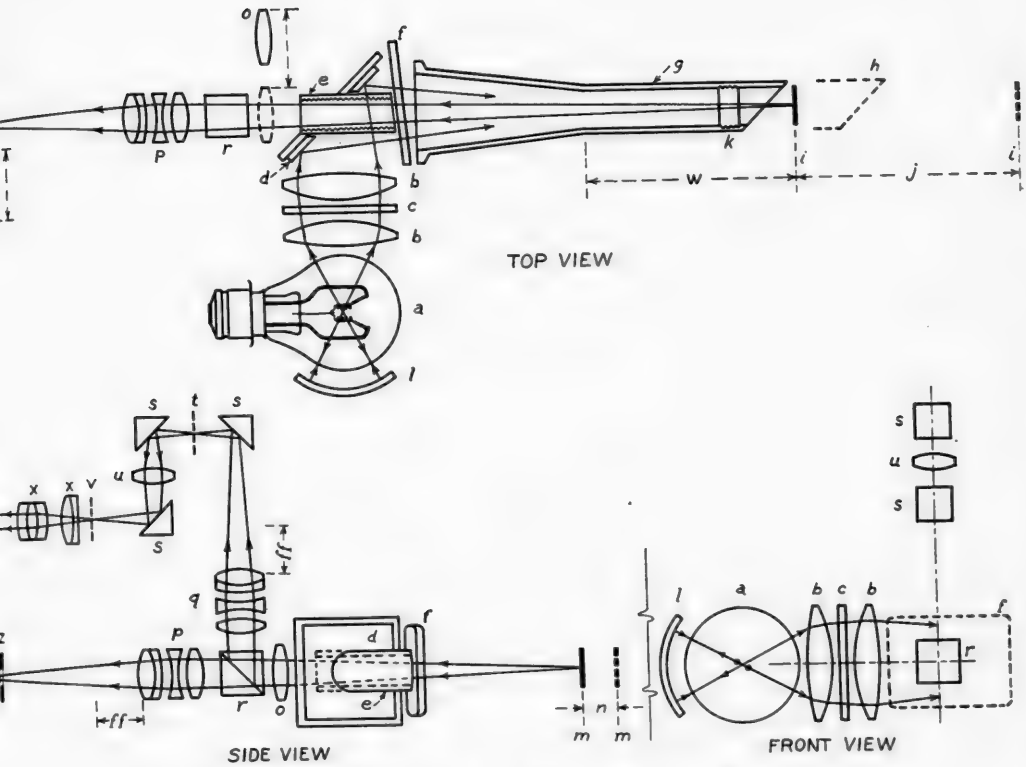


Figure 8. Optical Drawing of Camera (Diagrammatic).

a — 240 watt airplane headlight lamp, 12 volts 20 amperes
b — Condenser lenses
c — Heat-absorbing glass
d — 45 degree plane mirror
e — Round tube, threaded on inside
f — Optically flat glass slide
g — Laryngoscope
h — Tip of bronchoscope or esophagoscope
i — Plane of sharp focus at object
j — Range of focus adjustment (9 to 26½ inches from flange)
k — Threads on inside of endoscope to produce light ring around image on film
l — Spherical mirror
m — Object plane in sharp focus when supplementary lens "o" is used
n — Range of focus adjustment with supplementary lens (4 to 5 inches from flange)
o — Achromatic supplementary lens, 24.4 cm (9-5/8 inch) focal length
p — Camera lens, f.4.5, 90 mm focal length, tessar type
q — Telescope objective lens, f.4.5, 90 mm focal length, tessar type.
r — Beam-splitter cube, diverts light to telescope focuser
s — Front-surface mirrors to bring telescope eyepiece to proper position
t — Image plane of telescope objective lens
u — Telescope image—erecting lens. A 1 inch focal length, f.2.5 movie camera lens is used
v — Image plane at eyepiece
w — Free working length of laryngoscope
x — Eyepiece lenses
y — 16 mm motion picture film in camera
z — Movable mask. Four holes shown in top view. (Masks endoscope reflections from film)
ff — Focusing motion of camera and telescope-objective lenses

length lens (90 mm instead of 80 mm). The previous image/object ratio was 0.17; the new, 0.21. Larynx pictures through the regular direct laryngoscopes (figure 6-a) are the same size on the film as with the previous type camera. The special short laryngoscope (figure 6-b) gives a larger picture on the film than could be obtained with the previous type camera.

Depth of Field

The depth of field (sometimes called depth of focus) at the object plane of sharp focus, is about plus or minus 0.25 inch for a reasonably sharp image. This is for a maximum circle of confusion on the film of 0.004 inch. For a good practical value for sharpest possible image, the depth is only about plus or minus 0.125 inch when 0.002 is taken as the circle of confusion. Theoretically it is possible to show details which are imaged as small as 0.001 inch at the film plane, but 0.002 inch is a good working value for best results. Due to the motion of the screen image, occasional short scenes very slightly out of focus detract little from the general effect.

The general appearance of the image, as to depth of field, is approximately the same as the pictures taken with the still camera, when both are enlarged to the same size screen image. The depth of field values given are adequate for good work, and the out-of-focus parts of the image serve to orient the sharp part of the field.

Relative Magnification on the Screen

The image on the screen appears slightly enlarged above life-size when the pictures are projected. For most of the endoscopic areas the enlargement is about 1.6 life-size. This enlargement is based upon the included angle which the image occupies at the eye of the observer. For ear-drum pictures taken at 0.50 ratio on the film, the enlargement appears to be about 2.5 times life-size, approximately equal to the image seen in a magnifying otoscope.

The film area of one frame of 16 mm film seen on the screen, is 0.284 inch high by 0.380 inch wide. From the values found in the last column of figure 7, it is seen that bronchoscopic pictures are 40 per cent of the screen height, and the large laryngoscope pictures are 60 per cent. Mirror pictures of the larynx are about 90 per cent of the full height. Ear-drum pictures are about 45 per cent. The general appearance of the images, as to screen height, is seen in figure 10.

Supplementary Lens

The supplementary-lens slot, located just ahead of the focusing knob (figure 2) permits the use of an achromatic lens of 24.4 cm (9⅝ inch) focal length for photography of the ear-drum. The maximum diameter of field which can be photographed without the ear-speculum

is ½ inch. This full diameter of the field may be used when photographing a small surface area of skin or a cavity such as a nostril or ear-canal at a relatively high magnification. This use is macro-cinematography[9]. For ear-drum photography, an ear-speculum of 6 mm diameter is used. The image on the film is about 0.125 inch (3 mm) in diameter. The depth of field is about plus or minus 0.125 inch (3 mm) from the plane of sharpest focus, for a circle of confusion of 0.003 inch on the film. The supplementary lens slot is filled with a dummy lens carrier when photographing in the normal endoscopic focusing range.

Camera Handle

The camera handle is notched to provide a comfortable and secure grip. The index finger is free to operate the trigger camera release. The handle is located so that the center of gravity of the camera is balanced over the hand when the camera axis is tipped forward to 25 degrees from the horizontal—the approximate angle of the endoscope when the patient is in the recumbent position for direct peroral endoscopy. A threaded hole for a tripod is located in the bottom of the handle to support the camera while taking mirror pictures of the larynx, or for taking pictures at the supplementary distance.

Technic

The endoscopes are heated to slightly above body-temperature by an electric heating pad or by a brief immersion in the sterilizer just before use. Condensed moisture on the inner surface of the endoscopes would reduce the reflection of photographic light from the lamp. The glass slide for the camera is heated for about one minute in the top of the lamp-house; the heat from the lamp keeps it warm after it is inserted in the camera slot. A spare glass slide is available should the slide in the camera become spattered if the patient coughs.

An assistant winds the camera when necessary, and checks the f. stop used. He receives the camera from the endoscopist when it is detached from the endoscope.

The endoscopes may be introduced into the patient with the camera attached, since the lamp and telescope give full visualization of the field at the endoscope tip. The quick-acting attaching clamp for the endoscopes provides instantaneous release of the camera for aspiration of secretions by suction tube if necessary. In order to observe the endoscopic field when the camera is detached, a light-carrier from a standard bronchoscope of proper length is used, held inside the endoscope. Light-carrier canals and suction tubes are not built into the endoscopes since they would encroach upon the circular field and detract from the appearance of the finished film.

While the endoscope is being introduced, the plane of sharp focus

is set just beyond the endoscope tip. The moving field is photographed to demonstrate the landmarks seen during the introduction of the various instruments. The plane of sharp focus is then set at a suitable distance ahead of the endoscope tip, and the endoscope slowly advanced or withdrawn with the camera running, in order to show the moving field as seen during an endoscopic examination. In this way it is possible to take a series of scenes fully simulating a bronchoscopic examination.

The location of lesions or obstructions in either main bronchus is easily demonstrated by first photographing the carina and then proceeding down the respective bronchus to the lesion or obstruction. The position relative to the upper-lobe orifice often can be shown. The

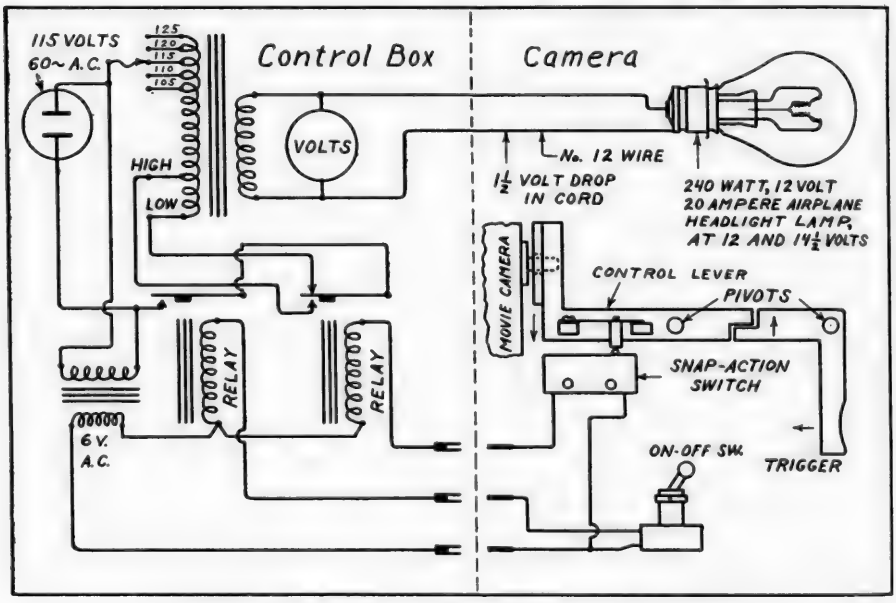


Figure 9. Electrical and Control Diagram of Camera.

relative position of an esophageal diverticulum can best be shown by first photographing the open lumen of the esophagus and then swinging over to the diverticulum (pouch); a return to the open lumen completes the scene.

Contrary to general opinion, it is more difficult to obtain satisfactory pictures of the vocal cords and larynx by the indirect mirror method than through the direct laryngoscope. The usual technic is to support the camera on a tripod, with the mirror light-directing tube attached. The laryngeal mirror may be attached to the mirror tube, or held independently in the operator's hand while the tongue is held out of the way by the patient. It is often difficult to align the camera axis, mirror, and laryngeal axis simultaneously so that a good view

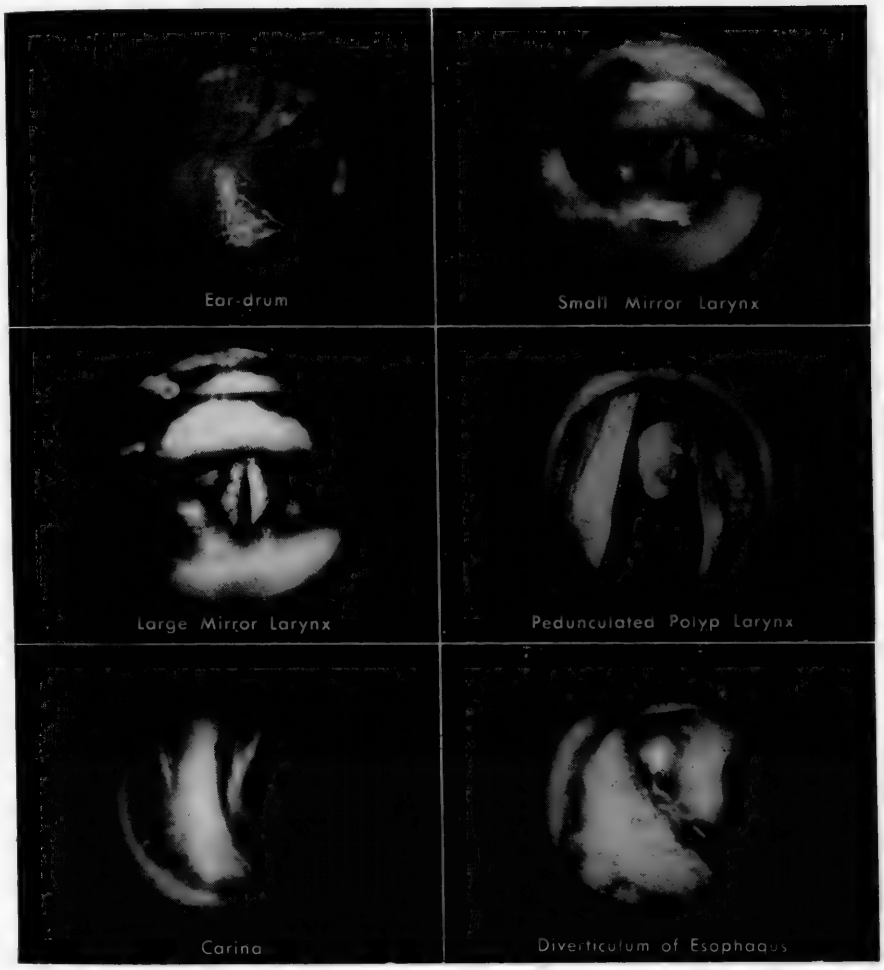


Figure 10. Black and white reproductions from single frames of 16 mm Kodachrome film to show size of image in relation to full screen height. Considerable detail has been lost in the copying process. (1) Normal ear-drum. (2) Mirror picture of larynx, using a small mirror. (3) Mirror picture of larynx, using a large mirror. The light area at the bottom of the picture is the out of focus image of the tongue. (4) Pedunculated polyp in larynx, taken through the large direct larynoscope. (5) Carina at the bifurcation of the trachea, taken through the bronchoscope. (6) Traction diverticulum of esophagus. Diverticulum at top, lumen of esophagus at right.

is had of the larynx; this is especially true with persons having a small pharynx. An over-hanging epiglottis often obscures the anterior commissure. There is a tendency of the tongue to rise into the path from mirror to lens, obscuring the field and reducing the photographic light intensity at the plane of the vocal cords.

The largest possible mirror should be used in order to show a large field. Where a small pharynx requires the use of a small mirror, the

narrow field seen in the mirror can be compensated for by tilting the mirror (while the camera is running) to scan the whole laryngeal field, showing each part in turn; this duplicates the scanning procedure used in a regular mirror examination of the larynx.

When the camera focus is placed at the vocal cords, the epiglottis and arytenoids are in reasonably sharp focus—sharp enough to identify the various anatomical landmarks of the larynx. Mirror pictures require a stop of f. 6.3 to f. 8 depending upon individual conditions.

The photographic lens aperture settings vary from f. 6.3 to f. 8 for the different areas photographed through open-tube endoscopes. At 16 frames per second, f. 7 is about average. Open lumen pictures require about f. 6.3, sometimes f. 6.8. Closed lumen pictures, especially when the field is light in color, require about f. 8. Direct pictures of the larynx may be made at 24 frames per second at f. 6.8. The exact setting is not extremely critical. There are very few failures due to improperly exposed pictures since the light reaching the field is of a constant pre-calibrated intensity. Satisfactory motion pictures are in some respects easier to make than still pictures, due to the continuous process of taking a series of pictures where focus is slightly less important than for still pictures. However, attention to scene length, field covered, subject matter, and continuity are important and must be considered.

Other Uses

Since the camera described is fundamentally a universal endoscopic type suitable for photographing through almost any of the common open-tube endoscopes or speculums, a brief discussion of its use in proctology and gynecology is indicated.

For proctology, a sigmoidoscope of 13 inches total length may be used, the same as recommended for the still camera. The largest diameter practicable is recommended in order to obtain a large field. The free working length of 7¾ inches (20 cm) is satisfactory for most proctoscopic cinematography, and provides a reasonably large image on the film. A free working length of 6 inches (15 cm) is sufficient for much proctoscopic photography, and would provide a larger image on the film. In the latter case, the total endoscope length is 11¼ inches. The simulated perspective effect is seen in proctoscopic cinematography as well as in per-oral cinematography. The endoscope is first introduced with an obturator in place. The obturator is then withdrawn, and the field examined with a light stick held inside the sigmoidoscope. After the desired field is located, the camera is attached and the pictures are taken. The bowel wall may be scanned as the endoscope is withdrawn

while filming. Additional descriptions of technics, and photographic illustrations of proctoscopic views have been published elsewhere[4, 6, 8].

For photography of the cervix uteri, light-directing tubes of various diameters are suggested; the maximum diameter usable on this camera is about 1 to 1¼ inches (2.5 to 3 cm). Since the film area in the camera is limited to ¼ inch, the light-directing tubes must not be shorter than 10 inches total length in order to have the whole object field appear on the film. In this case, the field is planned to be about 13 to 15 inches from the attaching flange of the light-directing tube. The tube diameter should be slightly smaller than the opening in the vaginal speculum, to avoid light reflections from the proximal portion of the speculum blades. The camera, with its light-reflecting tube can be aligned externally with the axis of the speculum, and the pictures taken. It may be desirable to provide a short tubular sleeve attached to one blade of the speculum in order to hold the speculum axis in line with the camera axis. Without the alignment sleeve, it is possible to scan the field slowly when the whole area to be shown cannot be included at one time on one camera field. Scanning may induce a sense of perspective when the films are viewed, especially if the cervix is moved slightly by palpation.

Appendix

The important differences between the old and new types of endoscopic motion picture cameras are discussed here. The interchangeable endoscopes, coaxial telescope, and supplementary lens have been mentioned.

The new type camera accommodates endoscopes of the different lengths (laryngoscope, bronchoscope, esophagoscope) without taking the camera apart—there are no loose parts to change. In the former type camera[5], it was necessary to disassemble the camera in order to change from one length of endoscope to another. It was necessary to change masks inside the front of the film box, and to exchange the lens extension-tubes and telescope eyepiece-tubes. This wasted much time and caused confusion; it introduced the possibility of serious error since the telescope could erroneously be set for a 10 inch distance when the camera was set for a 16 inch distance. With the new camera all this is accomplishd by moving the focusing knob, and by moving the mask knob to select the proper film mask opening for the endoscope in use. On the new camera, the telescope eyepiece remains in one position at all times.

On the previous camera, the adjustable sleeve in the endoscopes, by which the total endoscope length was changed, was a somewhat inadequate means of adjusting the position of the plane of sharp focus in relation to the endoscope tip. The 1¼ inches range of adjustment was too short for some bronchoscopic and esophagoscopic photography. The adjustable sleeve joint could not be made mechanically stiff enough to insure the best alignment of the endoscope tip image and film mask under all conditions of use. Each endoscope is subject to some lateral bending pressure when it is in use. The new type

one-piece endoscope provides more exact alignment. The focusing lens system is substituted for changing the endoscope length.

As previously mentioned, the tungsten lamp is operated on its side in the new camera and allows more clearance below the lamphouse. The ribbon filament lamp had to be operated in a vertical position, with its socket below the camera base.

The telescope on the new camera provides more precise focusing because the telescope objective lens operates at a larger diameter f. stop aperture (f. 7). This, in effect, shortens the depth of field seen at one time. Furthermore, focusing by moving the focusing knob is more precise than by moving the whole camera and endoscope (previous type). The telescope axis is coaxial with the camera lens and endoscope in the new camera; with the former type, the optical axis of the telescope was at a slight angle to the endoscope.

The focusing system on the new camera provides certain other advantages. The ability to place the plane of sharp focus, as seen in the telescope, at any distance ahead of the endoscope tip is one of considerable value; this is in contrast to a mechanically fixed position for the plane of sharpest focus. Endoscopes of different lengths require only that the focusing knob be moved slightly to accommodate the difference in length. The focusing-lens system is the only completely satisfactory method of focusing upon the vocal-cords when mirror photography of the larynx is attempted, since the distance from mirror to vocal-cords varies in different persons.

The illuminating system in the new camera is somewhat similar to that of the still camera; both have a 45 degree mirror with hole through it, used to project the light onto the main axis of the camera and endoscope. This is in contrast to the light prism used on the previous type movie camera. This new method of illumination, with large diameter condenser lenses permits the one set of still camera endoscopes to be used on the movie camera and still camera interchangeably. In the previous type movie camera, the light prism projected into the lumen to the mid-line. This covered one-half of the camera lens, and the lens operated with an effective half-circle-shaped aperture; the out-of-focus images of bright spots at the object plane are more confusing with the half-circle lens aperture than with the smaller full circle aperture of the new type camera arrangement.

The optical arrangement of the former type camera prevented the use of a supplementary lens for ear-drum photography because the camera lens and telescope did not operate on the same axis. On the new camera, the supplimentary lens acts on both the telescope and camera lens at the same time.

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Shutter Shadow in Photomicrography

F. T. Jones

FAINT shadows like those shown in figure 1 appeared in some but not all photomicrographs taken with a Bausch and Lomb type R photomicrographic outfit at the Western Regional Research Laboratory. The spiral pattern was recognized as being like the openings between the leaves of the Betax shutter. The openings exist only while the leaves are moving between the open and closed positions of the shutter, therefore it is evident that the exposure responsible for the pattern must be made during the time the leaves of the shutter are moving. If the above explanation is correct it must follow that the shadow will be more noticeable in pictures taken with short exposures than with long exposures, because the fraction of the total time used during the moving of the shutter leaves must be larger for a short exposure than it is for a long exposure. Tests of this idea proved that the shadow is actually more noticeable for exposures of one-fiftieth and one-twenty-fifth seconds than it is for exposures of one-tenth second or longer. The shadow is not perceptible when exposures are longer than one-tenth second.

The fact that the light lines cover the entire field can be explained if the beam of light intercepted by the shutter is almost as large in diameter as the shutter opening. This reasoning suggests that an ordinary eyepiece whose eyepoint is normally close to the shutter would not give a shutter shadow because the cone of light is still small (about one-quarter inch or less) at the level intercepted by the shutter. Amplifying lenses such as the Ampliplan lenses which have been used for some photomicrographs give a large diameter beam (about 1½ inch at the shutter level), not only because the lens is of large diameter (about one inch), but also because it is about three inches from the shutter as required by the camera construction. That this is the correct explanation is proved by the fact that only those photomicrographs taken with the Ampliplan lenses show the shutter shadow. It is possible that an ordinary eyepiece, whose eyepoint is close to the shutter, would cast a shadow for very short exposures e.g., a few hundredths of a second, but the shutter used does not provide a speed less than one-fiftieth second (longer exposures being the rule in photomicrography). Tests made at one-fiftieth second shutter speed with ordinary eyepieces prove that the

Received for publication October 16, 1946, Western Regional Research Laboratory, Albany, California.

Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

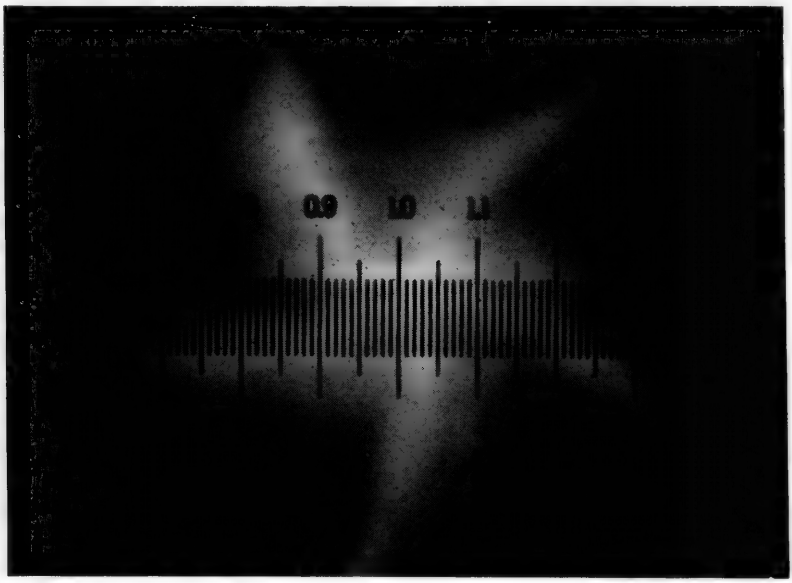

Figure 1. Spiral pattern formed by the shutter shadow.

shutter shadow will be faintly noticeable on a contrasty negative if the diameter of the light beam is 13 mm. at the shutter level. At a diameter of 23 mm. the shadow is distinct and at 44 mm. (the maximum shutter opening) the shadow is conspicuous. Most eyepieces will give a cone of light whose diameter at the shutter level will be less than 13 mm. when the light trap coupling is more than half over-lapped. The closer the shutter is to the eyepoint the smaller will be the shadow-casting fraction of the exposure time.

Several methods for avoiding or at least minimizing the shutter shadow when using amplifying lenses are obvious: (1) The time of exposure may be increased beyond 1/25 second, (a) by reducing the intensity of the light by closing an aperture diaphragm if this can be done without loss of image quality, by means of neutral filters, or by reducing the voltage on the lamp if color temperature is unimportant, or (b) by using a negative of slower emulsion speed. (2) The shutter may be placed between the light source and the microscope. (3) The exposure may be made by turning the light on and off although this is difficult to do for short exposures. (4) An emulsion giving lower contrast than a process film may render the shadow almost invisible, especially if the exposure can be made a bit darker than would ordinarily be done and contrast is avoided in developing. (5) The shutter may be placed as close to the eyepoint as possible. (6) A shutter whose leaves move faster, if such is available, may be used.

Color Correction for Precise Copying with Tri-Pack Materials

Clayton B. Oliver

KODACHROME transparancies of superior quality and reproduction characteristics are produced by the method to be outlined, however the general principles involved can be applied to other processes as well (Anscocolor, etc.). The principal factors of annoyance to the worker desirous of securing faithful reproductions from such copy can be classified into three major catagories, namely:

1. Color of illumination and/or reflection characteristics of the immediate surroundings.

2. Ultraviolet reflection of copy stock.

3. Spectral properties of the dyes or colors forming the copy, i.e., differences of absorptions between them and those utilized in the process involved.

As it is assumed that voltage regulation or at least the means of checking the voltage, and thus selecting the lamp of proper rating, is at hand to control the color emittance of the lamp itself, it will be found that the reflection of the surroundings, ultraviolet reflection of the copy stock, and to a great degree the absorption differences of the subject colors will be materially improved by this method. Such improvement being especially noticeable when printing is undertaken or when the transparancies are sent to a commercial establishment producing color prints.

The generally accepted criterion for color prints is the production of a neutral gray from a portion of the common step-tablet exhibiting an intermediate density; this same technic is employed in balancing a photomicrographic apparatus to the proper color temperature for the color process to be utilized, except instead of a medium density that of a clear glass area is used and proper density obtained by underexposure (assuming the photographic process to be of the reversal type, i.e., Kodachrome, Anscocolor, etc.). The method outlined herewith is an adaptation hinged on the basic concept of the above, and embraces two distinct functional phases; 1. The determination of the compensation required by underexposing a clean area of the stock upon which

Received for publication September 9, 1946, Wayne University, Detroit, Michigan.

the original is placed (or separate piece of similar material) to the proper degree so as to produce the required medium density, together with the taking of trial exposures with the various color-compensating filters to produce a neutral gray tint at that density; 2. Final exposure variations (at or within .8-1.4X recommended white card film speeds) to produce required over-all final transparency density and/or color intensity.

So far as the exposure necessary to obtain the proper density for such determinations it was found that one approximating one-quarter to one-third normal was about right. (Based on the use of Kodachrome type B, old type, i.e., not the improved speed emulsion now supplied). It can probably be assumed that this would also be correct for the newer emulsions or for other similar processes, however a preliminary series ranging from one-eighth to one-half that calculated from normal ratings might be advisable, keeping in mind that a medium density is desired, one which is neither too light (approaching the clear area typical of a white background when given normal exposure) nor too dark (rendering it difficult to see through by transmitted light of normal intensity).

Since the voltage applied to the lamps is assumed to be correct, or at least within plus or minus five volts, only a slight compensation will be required and the pale photometric filters supplied as correction (CC) units for use with the Eastman Color Temperature Meter or their primary series supplied for special purposes (or any similar product of Ansco or other manufacturer) will suffice. It is advantageous to use one of medium concentration in each group of each series, and then select the transparency revealing the nearest approach to such a neutral gray tint when viewed by daylight (indirect skylight, etc., never against the blue sky itself) or against an illuminator of daylight quality. If still considered insufficient then the deeper filter of the same category can be used for the final exposure but this has never been considered necessary in the author's applications. At the same time as the above series was taken another was exposed through the Wratten filters No. 1 (again other light, ultraviolet absorption filters could be substituted) using one, two and three thicknesses respectively. These were given only slight underexposure (¾ normal) and the earliest one to give a white (lacking in blueishness) background was chosen as correct while the number of filters required to obtain this were then used in combination with the correct compensating filter or filters, as determined above, in exposing for the final transparency.

After this has been accomplished one merely places the selected filters over the lens, returns to normal exposure times, and retakes the

copy with full assurance that the best possible transparency will result. Here is where certain exposure tolerances are allowable to permit slight alteration of color intensities, and in this relation it has been found that from 7/8—1¼X normal represents the maximum range. It was also discovered that the values were not distorted within this range when the process was first balanced as described, while without the use of this procedure, a certain amount of distortion was encountered. As an example, one copy seemed to take with a bluish-green background cast and while the ultraviolet filters alone removed the blue portion to an acceptable degree a slight greenish tone could still be detected. In this particular instance it was desired to increase certain light red portions without distorting the relative values of other colors, but a decrease in exposure only emphasized this greenish tint to an extent where certain pale blue regions took on a greenish cast also (a magenta correction filter was also tried at normal exposure which built up the reds only, and by this means the visual impression received upon viewing the slide was identical to a weakening of the blue area even though this was not technically true). After balancing the setup in conformation with this plan the greenish cast was removed and a decrease in exposure intensified both the red and blue areas in like degree resulting in a brilliant and well balanced transparency, completely devoid of the offending background tint.

While at first glance this might seem a highly complicated procedure it actually is not exceedingly difficult to execute, and as previously mentioned it is only considered on the basis that the best possible transparency or color print is desired; it will also be found that a compensation once worked out will apply to all similar types of originals. In practice it is believed that the blanket insertion of a pair of Wratten No. 1 filters would control the ultraviolet factor without being detrimental in cases where they were not necessarily required, thus simplifying the procedure to merely a color compensation determination.

A Photographic Apparatus for Use with Micro Tessar Objectives

John E. Sass

Abstract. The apparatus consists of a filament lamp with aspheric condenser, a revolving stage and a camera unit, mounted on sliding fittings that operate on a horizontal optical bench. The three principal units are easily kept in permanent, straight-line alignment. Micro tessar objectives with matching substage condensers comprise the optical system.

THIS apparatus was designed to take photomicrographs by transmitted light, at magnifications up to 25 diameters. The exclusive use of permanent slides makes possible the use of a horizontal optical bench, which affords a permanent straight-line alignment of optical and structural parts. The optical system consists of a set of micro tessar objectives and a matching set of substage condensers.

The base consists of two sections of optical bench screwed to a heavy oak board. Sliding fittings carry the three principal units, the camera, the stage assembly and the lamp. (Figure 1).

The 4 x 5 inch camera was obtained from an old Bausch & Lomb model H apparatus. A removable adapter permits the use of 9 x 12 cm. metal film holders. The focusing screen and focusing magnifier are of the conventional type. The lens board consists of an aluminum outer plate and an inner plate of ⅜ inch hardwood. The helical focusing mount, salvaged from a German instrument, is permanently fastened to the lens board. An adapter ring in the focusing mount permits the interchanging of 72, 48, 32 and 16 mm. micro tessars.

The shutter was made from the thin sheet metal of a film pack. The two leaves are actuated by a lever that slides in oblique opposed slots in the leaves. (Figure 2.) The shutter assembly is mounted on the wood inner plate of the lens board, and is operated by a lever above the focusing mount.

The revolving, non-centering stage was salvaged from an ancient German microscope. The substage condensers fit into a brass sleeve in the stage. The brass plate that holds the revolving stage is fastened to the sliding base by bolts that operate in slots which permit some

Received for publication March 6, 1947, Botany Department and the Botany and Plant Pathology Section, Iowa Agricultural Experiment Station. Project 182. Journal Paper No. J-1412.

Figure 1. Concise illustration of the principal units of the apparatus.

vertical and lateral adjustment of the stage assembly and its condenser. The stage assembly also carries a filter holder. A water cell has not been considered necessary.

The light source is a 6 volt 100 watt ribbon filament lamp, provided with an aspheric condenser and a diaphragm. A lock screw on the spiral focusing barrel of the condenser maintains its adjustment.

The following procedure is recommended for setting up the apparatus and for periodic checking of the alignment. Remove the substage condenser and the objective and turn on the lamp. The image of the filament should be in the center of the ground glass. Remove the ground glass and place a sheet of paper behind the camera at a distance at least 200 times the focal length of the lamp condenser. Focus the filament image on the sheet of paper; the lamp is then projecting a beam of approximately parallel rays.

Insert the desired objective and the substage condenser of the same focal length. The condenser should be almost in contact with the preparation. Bring the image into approximate focus by sliding the front of the camera, then move the back of the camera until the desired image size is obtained. Focus sharply by means of the focusing mount of the objective and take the photograph in the usual manner.

To determine the magnification, place a transparent millimeter ruler on the stage and measure its projected image on the ground glass.

Several improvements will be made when components become available. A well corrected lamp condenser is imperative for color photography. A centering mount for the substage condenser would facilitate precise centering. A section of optical bench that will receive the slid-

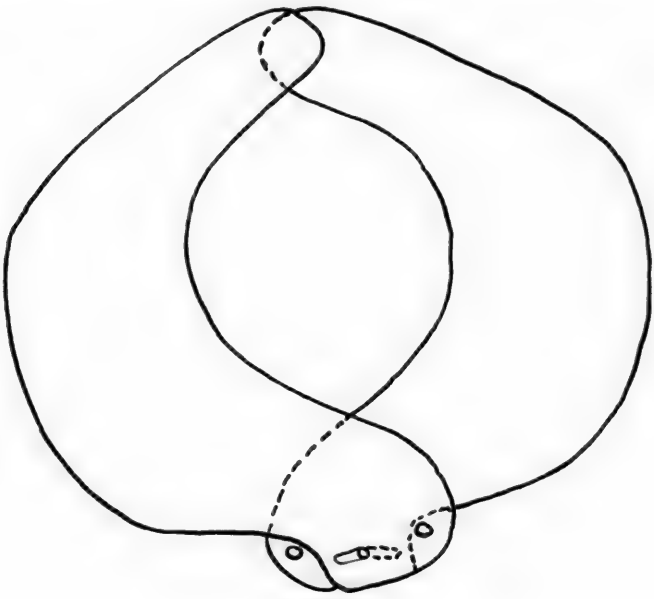

Figure 2.

ing fittings of the camera will be installed in the vertical position on a heavy base. This will permit quick transfer of the camera assembly from the horizontal, transmitted-light apparatus to a vertical apparatus for photographing seeds and other small objects by reflected light.

The use of a light of higher intensity, or the use of more rapid emulsions would necessitate the installation of a conventional shutter with timed intervals.

Association News

Mr. Ferdinand Harding has been appointed Consultant in Photography at Chelsea Naval Hospital. His duties will include making surgical motion pictures, supervising clinical photography and teaching the fundamentals of medical photography to enlisted personnel. This work will be done in the evening, as he still is full-time Director of Photography at the Children's Hospital.

Dr. Oscar Richards has been elected first vice-president of the American Microscopical Society.

Dr. Harry E. Morton of the University of Pennsylvania, who accepted an appointment to our Motion Picture Committee in 1946, has been elected president of the Eastern Pennsylvania Chapter of the Society of American Biologists.

The excellent chapter on photography in the symposium "Medical Research" reviewed in our Journal for March 1947 (Vol. 15, p. 142) was written by two of our members, Dr. Milton G. Bohrod and Mr. H. Lou Gibson.

Mr. William Martinsen has moved from Chicago to Los Angeles, where he is in charge of photography at the Veterans' Center. As the Center has never had a photographic department he is deep in organizational work at present. A full program of medical photography is being planned, to be undertaken as soon as the department is ready.

Mr. Deam H. Ferris, who joined the BPA in 1945, was Chief of the Photographic Service at Camp Detrick for three years during the war. He had been assigned to the then highly secret biological warfare unit at Edgewood Arsenal as a parasitologist but because of previous photographic experience he was soon in charge of a heavy photographic program which included color-printing, color motion pictures and many thousands of black-and-white prints a month. During off-hours, he trained personnel in his own quarters, as there were never enough trained photographers to keep up with the work.

After the war he continued at Camp Detrick with the rating of Photographic Specialist (Scientist) P-3 in the Civil Service for six months, and then went to Wisconsin University as Instructor in the Photographic Department. There he is taking his Ph.D. in Parasitology and writes that his thesis will be titled "The Role of Photography in the Biological Sciences, with Special Emphasis on Parasitology." His problem will encompass two main points: (1) The use of photography to solve a specific problem in parasitology; (2) Development of new

equipment and new techniques in photography of parasites and biological photography in general. Pictures will be a basic part of his thesis for he hopes to incorporate motion pictures and slides of the complete life cycles of two parasites never before completely described. In so doing he hopes to demonstrate that photography is not merely a tool, or method of presentation, but a means of obtaining data in its own right.

Mrs. Leopoldina Grabherr of the Department of Public Health, Santiago, Chile, has reached home after completing six months training in medical photography in the United States. Her trip was made possible through a fellowship granted by the Inter-American Cooperative Public Health Service in Chile; and her training here was under the auspices of the Institute of Inter-American Affairs.

So far the Institute has sent about 700 Latin Americans to train in the United States for work in public health. Qualities that win scholarship are professional attainment, talent, qualities of leadership and interest in the welfare of fellow countrymen.

Mrs. Grabherr's study included training at the Rockefeller Institute for Medical Research, New York City; Columbia University; Eastman Kodak Co.; Mayo Clinic; Ansco; and the Carnegie Institute of Baltimore. She also visited the Army Medical Museum and the Naval Medical Center in Washington; the Rochester General Hospital; the Rochester Institute of Technology; the Bausch and Lomb Co. in Buffalo; the College of Medicine, Syracuse University; the Marquette University School of Medicine; and the Magee Hospital of the University of Pittsburgh Medical Center.

Mrs. Grabherr and her husband, both of whom are professional medical photographers, joined the BPA in 1942. They had kept in touch with the Association by correspondence since then, and Mrs. Grabherr saw many of our members when she came to the United States. In New York City she was in touch with Joseph Haulenbeek and Julius Weber; in Rochester, N.Y., with Adrian Ter Louw, H. Lou Gibson, Charles Foster, Roger Loveland, Dr. M. Bohrod, John Beiter, and John Butterfield; in Syracuse, Stella Zimmer; in Buffalo, Oscar Richards; at the Mayo Clinic, Leonard Julin, Stanley McComb, Leonard Coffey; at Marquette University, Leo Massopust; in Pittsburgh, Anne Shiras and Albert Levin; in Baltimore, Dr. Osborne Heard.

She specialized in color techniques during her stay here. Because of the opportunities she had of observing photographers in the United States and working some of the processes herself, she felt confident of being able to adopt the various methods in her own laboratory. As she

remarked just before her take-off for Chile by air "I go home with much wind in the wings."

A member from India has recently joined, Mr. Kunji Lall Gahlot, of K. L. & Sons, Bikaner, India. The firm of K. L. & Sons deals in photographic materials. Mr. Gahlot has had fifteen years experience in the field of photography, and is a graduate of the New York Institute of Photography in portraiture, commercial and color photography. His Highness the Maharajah of Bikaner, himself a photographic enthusiast and greatly interested in post-war development, sent Mr. Gahlot to the United States to obtain specialized training in photography. He spent seven months in this country with various photographic and optical firms. In India he will assist in improving photographic methods as applied there, and will establish photography in the hospitals of that area.

BPA Facts and Figures

Our greatest membership concentration naturally continues in the northeast, but California has increased her membership percentage by two per cent since 1942 and Illinois by one per cent. Active chapters in both these states are responsible for the growth. 21% of our members are in New York state; 4% in Massachusetts; 9% in Pennsylvania; 4% in Ohio; 9% in Illinois, and 9% in California. The rest are scattered through the various states in smaller percentages. Seven states in the west and southwest still have no members. 3% are in foreign countries.

From the standpoint of occupation, 37% of our members are full-time medical photographers; 2% are full-time photographers in the biological sciences other than medicine; 5% are technicians who do part-time scientific photography; 5% are either full-time or part-time photographers in business concerns; 28% are scientists in the medical field; 14% are scientists in other fields, such as biology, botany, entomology, etc.; the other 9% are scattered among various categories: photographic manufacturers, photographic dealers, experts in crime detection, students, amateurs, etc.

When we last published data (Vol. 11, P. 34, Sept. 1942) 14% of our members were women. With the war's end, however, men have been joining more rapidly, and at present women make up 10% of our membership.

Chapter News

Boston

In November Miss Muriel McLatchie, medical illustrator, and Ferdinand Harding, medical photographer, gave a talk to a combination

meeting of illustrators and photographers on "Technique Differences in the Operating Room". Each told how they worked and what they did.

The next meeting was not held until March, when Adrian Iorio talked on "Drawing for Publication." That same evening Floyd Miller of the Barta Press spoke on "Proper Drawing from the Printer's Standpoint."

As no news has been received about elections, we assume the officers are the same as they were formerly: Ferdinand Harding, Chairman; Laurence Brown, Secretary-Treasurer.

CHICAGO

Maria Elsasser Ikenberg sends the following list of meetings held during the winter of 1946-1947:

October 15, 1946—The York Microstat Company of Illinois: "Copies of X-Rays on 35 mm. film".

November 19, 1946—Mr. Thomas Hill, Edwal Laboratories: "Variations in Photography".

December 19, 1946—Christmas Dinner followed by Meeting. Mr. Ralph Creer: "Illustrated Lecture on Post-war Europe."

January 21, 1947—Mr. Arthur Morrison, Chicago School of Photography: "Miscellaneous Photographic Lenses."

February 18, 1947—Dr. Jules H. Masserman, Northwestern University: "Research in Alcoholism"—Motion pictures.

March 18, 1947—"How to Make a Scientific Motion Picture" film of the American College of Surgeons, followed by a discussion under the direction of Mr. Ralph Creer.

April 15, 1947—"Photomicrographs in Ansco-Color"—A practical demonstration under the direction of Mr. Jean Crunelle.

May 20, 1947—A demonstration of Ektachrome.

At the January meeting the following officers were elected:

President: Charles Lindsay

Vice-President: Jean Crunelle

Secretary-Treasurer: Maria Ikenberg

Directors: Ralph Creer, Dr. Tibor Benedek, Don Burge

Ex-Officio: Dr. Jay M. Garner

William Martinsen was elected Honorary Member of the Chapter.

Cleveland

As we go to press no news has come from the Cleveland Chapter. We know however that it has been holding meetings during the 1946-47 season, and have every reason to believe it is thriving. We will try to give you a report of it in the next number.

Los Angeles

The Secretary, Avis Gregersen writes: "At each meeting we have what we call "Kodachrome Clinic" which seems to prove interesting to all our members. We each bring a few Kodachromes for projecting and the maker discusses what he did, the subject material, etc. Sometimes a member brings some that are all wrong and asks what to do to correct them."

Programs for the season 1946-47:

September—Report on National BPA Convention in Chicago—Edward N. Hamilton.

October—E. J. Schaefer: "New Eastman Ektachrome Films" Processed.

November—Mr. Kent: "Kluge Electronics". Demonstration.

December—Lloyd Matlovsky: "Theory of Macrophotography, Lens Calibration".

January—A trip through the White Memorial Hospital Photographic Laboratory.

February—A visit to our Mr. James Smith's Home Photographic Laboratory.

March—Frank Crandell: "Incident Light Measurements and Its Relation to Photographic Exposure".

April—Lloyd Matlovsky: "Simple Considerations of Densitometry and Sensitometry".

Meetings

Dr. R. G. W. Ollerenshaw spoke on "The Production of the Surgical Teaching Film" at the March meeting of the Royal Photographic Society, Medical Group.

In "Graphics", the informal and enjoyable publication of the Association of Medical Illustrators, Lewis Waters, Chairman of the Executive Committee, announces that the 1947 meeting of the Association will be held in New Orleans, La., September 29th to October 2nd.

Graphics was edited by Miss Helen Lorraine, 5212 Sylvan Road, Richmond 24, Virginia. The first number came out in March. As yet no regular schedule of publication has been planned.

New Journal Cover

We are planning a new cover for Volume 16 of our journal. It will consist of a spread of photomicrographs. The selected prints will be used in the four issues of Volume 16 with a change in the color of each issue. Any member of the BPA may contribute. Credit will be given for the entries selected. These photomics must reach the editor anytime before July 15.

(Continued from Inside Front Cover)

time the convention opens if you have material in mind that will be helpful to the Association members. If this shoe fits, please write John Butterfield about your contribution as soon as possible for it is the intention of the committee to complete the program by August 1. Send him a short synopsis of the material to be presented and the approximate time required.

A most interesting speaker has been obtained for the Banquet. Dr. Kenneth C. D. Hickman, Vice President and Director of Research, Distillation Products, Inc., Rochester, New York, is an outstanding chemist and physicist in the fields of photographic theory and application, and molecular distillation. He independently invented apparatus for molecular distillation that subsequently has been employed for the extraction of oils for paints, dyes and other materials. As an outgrowth of this method of distillation, he has been able to separate the various vitamins out of fish oils. As a result of his very extensive research activities in the field of nutrition, he has become the focus of a great deal of medical attention with respect to vitamin investigations. In the field of photography, Dr. Hickman is responsible for the theory of photographic exposure and a number of other theories connected with photographic inquiry. He has also been a developer of ingenuous instrument designs and methods that have been employed in his various research activities. An outstanding piece of work in photography has been his electrolytic method for the recovery of silver from fixing baths. On the other side of his scientific character, Dr. Hickman is particularly interested, at the present time, in the philosophical attitude exhibited by research workers toward the scientists' responsibility to the world. Dr. Hickman is a most entertaining and stimulating speaker and it is with a great deal of pleasure that we announce his acceptance to speak at our next annual banquet.

One of the highlights of the convention program will be a series of papers on medical photography. It will be arranged as for a symposium, and it is expected that stimulating discussion will ensue. A number of experienced people will be present to answer many of the questions that will be asked. In this connection, it is requested that all those photographers engaged in medical activities be prepared to discuss the numerous problems that will be presented. Those who would like to contribute to the program, please so advise Mr. Butterfield.

By this time, all members of the Biological Photographic Association have received a copy of the entry blank for the Exhibition of Biological Photography that will open on September 10 and terminate on September 27, 1947. The committee urges all those contemplating sending their contributions to the exhibition to do so at an early date. Do not wait

until the last minute to suddenly realize that your good intentions may be neutralized by the deadline of August 1. The Association in expecting all of its members to contribute examples of their work and to have them shown in as outstanding a show as this exhibition is fore-ordained to be.

If additional copies of entry blanks are needed so that you may include your other biological photographic workers in the exhibition, please do not hesitate to request them from Mr. H. Lou Gibson, 343 State Street, Rochester 4, New York. Widespread interest is being shown in the exhibition because it is the only opportunity of its kind that has occurred in several years for scientific photographers to exhibit and compare their work. As mentioned in the March issue of the Journal, three outstanding photographic personalities will judge the exhibition. We feel that it is the duty of every B.P.A. member to extend the scope of the exhibition as much as possible, and it will, therefore, necessitate a little bit of salesmanship on the part of each member in order to make possible as big and important an exhibition as it is possible to create.

A. W. FUCHS, F.B.P.A.
General Chairman

Book Review

Better Photography, by Lester Loeb. 274 pages. Published by the Philosophical Library, 15 East 40th St., New York 16, N.Y. $3.00.

This is a different book on photography. It is as non-technical as a book on photography could possibly be, and still explains the author's ideas clearly. The spirit in which the book is written is admirable,—the author calls cameras, films, papers and other equipment *by name.* Too many books of this type have been written in a generalized style, leaving the reader puzzled. Loeb's book eliminates that fault, and thus is better than average, although one may not always agree with the author's conclusions. The volume is well illustrated and has an excellent index. The amateur will gain many fine ideas for his hobby, and will be a better photographer after having read "Better Photography".

Ray Miess.

Kodak Park from the air . . . Covers 400 acres, contains 99 major buildings. In front, at the center, is the Kodak Research Laboratories' principle building. Kodak Park West and Kodak Park Far West extend beyond.

September 10-13, 1947

Welcome to the BPA convention at ROCHESTER, N.Y. This beautiful city is bordered by the blue waters of Lake Ontario, located on the banks of the Genesee River in the heart of the Finger Lakes Region and has a population of 402,860. You will see the surrounding territory of this city with its fall raiment of scarlet and gold. Rochester is easily accessible to most members of the BPA, an overnight ride from home for three-fourths of the population of the United States! Hotel accommodations are excellent. The city boasts an attractive downtown section and amusements of every variety. Gigantic industrial plants, the Eastman Kodak Co., Bausch and Lomb Optical Co., Taylor Instrument Co., and 1,500 other concerns have made Rochester famous throughout the country and the world. For business *and* pleasure, come to Rochester, 1947 BPA Convention host.

Bausch and Lomb Optical Co., 635 St. Paul St., the world's greatest manufacturer of optical goods. Products include optical glass, binoculars, precision instruments, etc. Genesee River in background.

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